Klamath Falls and Oakridge 2017 Exceptional Event EPA Concurrence Request

Submitted to: EPA, Region 10
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Executive Summary

To address high monitor values resulting from exceptional events not reasonably controllable or preventable, the U.S. Environmental Protection Agency promulgated the Exceptional Events Rule pursuant to Section 319 of the Clean Air Act. Major changes to the 2007 EER contained in the Code of Federal Regulations, Title 40, Parts 50 and 51 (40 CFR 50 and 51) were promulgated on October 3, 2016 (72 FR 13560) to clarify the scope of the rules, analyses, content, and organization for exceptional events demonstrations, and fire related definitions and demonstration components. The EER allows states to flag air quality data as exceptional and exclude those data from use in determining compliance with the National Ambient Air Quality Standards if EPA concurs with the state's demonstration that it satisfies the rule requirements.

Following the EER procedures, Oregon Department of Environmental Quality flagged values at the Klamath Falls Peterson School and Oakridge monitors and is requesting concurrence that certain flagged values (Table 1 and 2) are exceptional events. The PM2.5 flagged values close to or over 35 micrograms per cubic meter ($\mu g/m^3$) affect Oregon's compliance with the 24-hour PM2.5 National Ambient Air Quality Standard (NAAQS). DEQ demonstrates in this report and requests EPA concurrence that these exceptional concentration values occurred as a result of wildfires, they were not reasonably controllable or preventable by the State of Oregon, not likely to reoccur, and they fully meet the EER criteria for excluding monitor values from the data used to determine compliance with NAAQS. At this point, we are only requesting concurrence for days that are of regulatory significance, and are providing information for days that may become regulatorily significant in the future.

Tables 1 and 2 show the key fires or fire complexes causing event days in Klamath Falls and Oakridge, respectively, associated with our request of EPA to concur with our findings.

Table 1. Monitor values at Klamath Falls for which DEQ is requesting EPA concurrence

Date	24-hour average PM2.5 (µg/m3) EPA # 41-035-0004, POC 1	Most likely source
8/17/2017	**34.6**	**Umpqua North / High Cascades Complex**
8/20/2017	55.1	Umpqua North / High Cascades Complex
8/23/2017	**32.7**	**Umpqua North / High Cascades Complex**
8/26/2017	44.7	Umpqua North / High Cascades Complex
8/29/2017	69.3	Umpqua North / High Cascades Complex
9/1/2017	50.6	Umpqua North / High Cascades Complex
9/4/2017	102	Umpqua North / High Cascades Complex

Table 2. Monitor Values at Oakridge for which DEQ is requesting EPA concurrence

Date	24-hour PM2.5 (µg/m3) [EPA # 41-039-2013_01]	Most likely source
8/26/2017	42.2	Chetco, accumulated valley smoke?
8/29/2017	88.5	Willamette Forest fires
9/1/2017	86.2	Willamette Forest fires
9/4/2017	200	Willamette Forest fires
9/7/2017	66.9	Willamette Forest fires

9/16/2017	40.3	Willamette Forest fires

In addition, Tables 3 and 4 show that the requested values are the highest values recorded at the respective monitors for summer days (June 1 to September 30) from 2008-2017. Exceptional events days from prior years that have been concurred by EPA were removed from the data set.

Table 3. Rank Percent of requested values, 2008-2017; June 1-Sept. 30; Klamath Falls monitor

Monitor	Date	YR	FinePM	Flagged	Rank (N=381)	PCTL
KFP	**9/4/2017**	**2017**	**102**	**IT**	**381**	**100.0%**
KFP	**8/29/2017**	**2017**	**69.3**	**IT**	**380**	**99.7%**
KFP	**8/20/2017**	**2017**	**55.1**	**IT**	**379**	**99.5%**
KFP	**9/1/2017**	**2017**	**50.6**	**IT**	**378**	**99.2%**
KFP	**8/26/2017**	**2017**	**44.7**	**IT**	**377**	**99.0%**
KFP	**8/17/2017**	**2017**	**34.6**	**IT**	**376**	**98.7%**
KFP	8/2/2013	2013	33.6		375	98.4%
KFP	**8/23/2017**	**2017**	**32.7**	**IT**	**374**	**98.2%**
KFP	8/3/2014	2014	31.4	IT	373	97.9%
KFP	9/16/2017	2017	30.3	IT	372	97.6%
KFP	8/28/2015	2015	29.5	IT	371	97.4%
KFP	9/8/2014	2014	26.3		370	97.1%
KFP	8/7/2008	2008	26.3		369	96.9%
KFP	7/4/2014	2014	25.5		368	96.6%
KFP	8/25/2015	2015	25.2	IT	367	96.3%
KFP	8/14/2013	2013	25.2		366	96.1%
KFP	8/17/2013	2013	25		365	95.8%
KFP	9/13/2017	2017	24	IT	364	95.5%
KFP	8/27/2014	2014	22.5		363	95.3%
KFP	8/14/2017	2017	22.1	IT	362	95.0%

Table 4. Rank Percent of requested values, 2008-2017; June 1-Sept 30; Oakridge monitor.

Monitor	Date	YR	FinePM	Flagged	Rank (N=407)	PCTL
OAK	**9/4/2017**	**2017**	**200.0**	**IT**	**407**	**100.0%**
OAK	**8/29/2017**	**2017**	**88.5**	**IT**	**406**	**99.8%**
OAK	**9/1/2017**	**2017**	**86.2**	**IT**	**405**	**99.5%**
OAK	**9/7/2017**	**2017**	**66.9**	**IT**	**404**	**99.3%**
OAK	**8/26/2017**	**2017**	**42.2**	**IT**	**403**	**99.0%**
OAK	**9/16/2017**	**2017**	**40.3**	**IT**	**402**	**98.8%**
OAK	9/22/2009	2009	36.5		401	98.5%
OAK	8/20/2017	2017	**33.3**	IT	400	98.3%
OAK	9/14/2014	2014	32.2		399	98.0%
OAK	9/8/2014	2014	31.1		398	97.8%
OAK	8/8/2017	2017	**31.0**	IT	397	97.5%
OAK	8/23/2017	2017	**26.7**	IT	396	97.3%
OAK	8/13/2015	2015	25.9		395	97.1%
OAK	9/17/2014	2014	23.9		394	96.8%
OAK	8/27/2014	2014	22.4		393	96.6%
OAK	8/25/2015	2015	21.4	IT	392	96.3%
OAK	9/25/2009	2009	20.8		391	96.1%
OAK	9/18/2012	2012	18.3		390	95.8%
OAK	7/2/2008	2008	17.0		389	95.6%
OAK	8/19/2015	2015	16.9		388	95.3%

An evaluation of the 24-hour 98th percentile PM2.5 design value for 2017 for the Klamath Falls monitor with and without the requested exceptional event days shows that five days (8/20/17, 8/26/17, 8/29/17, 9/1/17, and 9/4/17) require removal from the dataset to lower the design value below 35 µg/m^3. Two additional days are requested (8/17/17 and 8/23/17) to achieve a buffer below the NAAQS for future consideration (see Table 5).

Table 5. Evaluation showing change in 24-hour PM2.5 design value for 2017 for Klamath Falls with exceptional event data removed

Monitor Reading Rank (highest to lowest)	24-hour average PM2.5 (µg/m^3)	Date	Data flagged?	Resulting design value if value removed from dataset (µg/m^3)	% of standard
122	102	9/4/2017	Y	55.1	57%
121	69.3	8/29/2017	Y	50.6	45%
120	55.1	8/20/2017	Y	44.7	28%
119	50.6	9/1/2017	Y	34.6	-1%
118	44.7	8/26/2017	Y	32.7	-7%
117	34.6	8/17/2017	Y	**32.2**[*]	-8%
116	32.7	8/23/2017	Y	31.8[!]	-9%
115	32.2	12/12/2017		**31.6**	-10%

[*] Design value if 5 values removed
[!] Design value if additional 2 values removed

An evaluation of the 24-hour 98th percentile PM2.5 design value for 2017 for the Oakridge monitor, with and without the requested exceptional event days, shows that six days (8/26/17, 8/29/17, 9/1/17, 9/4/17, 9/7/17, and 9/16/17) require removal from the dataset to lower the design value to within 5% of 35 µg/m^3 (see Table 6).

Table 6. Evaluation showing change in 24-hour PM2.5 design value for 2017 for Oakridge with exceptional event data removed

Monitor Reading Rank (highest to lowest)	24-hour average PM2.5 (µg/m^3)	Date	Data flagged?	Resulting design value if value removed from dataset (µg/m^3)	% of std
122	200.0	9/4/2017	Y	86.2	146%
121	88.5	8/29/2017	Y	66.9	91%
120	86.2	9/1/2017	Y	**42.2**	21%
119	66.9	9/7/2017	Y	41.6	19%
118	42.2	8/26/2017	Y	40.3	15%
117	41.6	12/12/2017		40.3	15%
116	40.3	9/16/2017	Y	38.6	10%
115	38.6	12/6/2017		**35.7**	2%
114	35.7	1/7/2017		35.7	2%

Required Elements of the Exceptional Event Rule

The EER requires that demonstrations justifying data exclusion as exceptional event must include the following:

(a) A narrative conceptual model that describes the event(s) causing the exceedance of violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);

(b) A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;

(c) Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times to support the clear causal relationship requirement;

(d) A demonstration that the event was both not reasonably controllable and not reasonably preventable;

(e) A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event; and

(f) Documentation that the State followed the public comment process and conducted at least a 30-day comment period.

In addition, a state must submit the public comments with the demonstration and address in the demonstration those comments disputing or contradicting factual evidence provided in the demonstration (40 CFR 50.14).

We organized the demonstrations by sections that address each element of the EER (Table 7).

Table 7. Summary of elements included in this demonstration.

EER Element	Section	Summary
Conceptual Model	1	The conceptual model describes the affected area, meteorological conditions of the region, and the source causing the violation. It includes a discussion of how emissions from the wildfire event led to the violation at the Klamath Falls and Oakridge monitors.
Clear Causal Relationship	2	Data are presented to demonstrate that the event affected air quality and that there is a clear causal relationship between the event and the exceedances: (1) Meteorological evidence: transport of emissions to monitor (2) Satellite and back trajectory evidence: spatial relationship between source and monitor (3) Time series evidence: temporal description of event days (4) Alternative sources
Historical Concentrations	3	Analyses are provided comparing the event-influenced concentrations at Klamath Falls and Oakridge to historical concentrations.

Not Reasonably Controllable or Preventable	4	A wildfire event meets the EER for this element (40 CFR 50.14(b)(4))
Human Activity Unlikely to Recur at a Particular Location or a Natural Event	5	The criterion meets the EER definition that wildfires predominantly occurring on wildland are natural events.
Mitigation	6	DEQ presents evidence of prompt public notification of the event, public education so that individuals could make behavioral changes to reduce exposure to unhealthy air, and implementation of appropriate measures to protect public health from the impacts of exceptional events.
Initial Notification	7	Demonstration of initial notification to EPA.
Public Comments	8	Documentation of the public comment process, public comments received and DEQ response to comments.

Introduction

The Oregon Department of Environmental Quality requests an exclusion of the fire measured exceedances of the 24-hour PM2.5 (fine particulate matter) National Ambient Air Quality Standards at Klamath Falls, Oregon, on 8/20/17, 8/26/17, 8/29/17, 9/1/17, and 9/4/17; and for the Oakridge monitor on 8/26/17, 8/29/17, 9/1/17, 9/4/17, 9/7/17, and 9/16/17. This demonstration provides evidence and narrative satisfying all the requirements set forth in the Exceptional Events Rule. The exceedances were the direct result of wildfire events that affected air quality at the respective monitors.

The conceptual model describes the event and how the emissions from the events led to the exceedances at each monitor on each day. It demonstrates that a clear causal relationship exists between the vent and the monitored exceedance. We compared the historical concentrations at the Klamath Falls monitor to the exceedance concentrations to support the clear causal relationship requirement. The wildfire event was both not reasonably controllable and not reasonably preventable, and it was a natural event. DEQ provided prompt public notification of the event, provided for public education concerning actions that individuals may take to reduce exposures to unhealthy levels of air quality during the event, and provided for the implementation of appropriate measures to protect public health from the exceedances caused by the event. Public comments on the demonstration and DEQ's responses will be included at the end of the document.

1 Conceptual Model

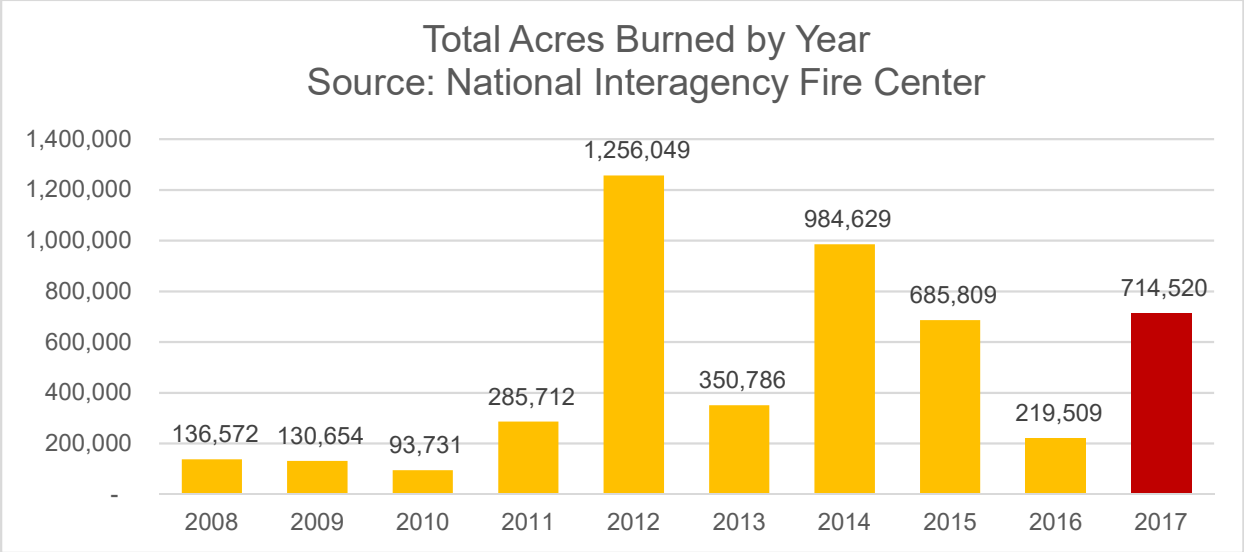
In August and September 2017, smoke from regional wildfires was transported to the Klamath Falls and Oakridge monitors. The Klamath Falls monitor recorded exceedances of the 24-hour PM2.5 NAAQS on 8/20/17, 8/26/17, 8/29/17, 9/1/17, and 9/4/17 and the Oakridge monitor recorded exceedances on 8/26/17, 8/29/17, 9/1/17, 9/4/17, 9/7/17, and 9/16/17 as a result of fires. The conceptual model describes the source of the fine particulate matter that impacted the monitor, the transport weather conditions that brought aerosols to the monitor, the estimated emissions of the wildfire sources, and the timing and magnitude of the events' impacts on the respective monitors.

1.1 Overview

Wildfires occur every year in the western United States during summer and fall. The 2017 wildfire season was, like most years, hot, dry, and smoky. Over 1.8 million acres burned in Oregon, Washington, and Idaho.[1] An additional 1.3 million acres burned in Montana and 3 million acres in British Columbia and Alberta, Canada. During the first full week of September, smoke from many of these fires was trapped in a multiday stagnation event. Smoke accumulated during that 5-day period and negatively affected the air quality throughout the northwestern United States. In addition, the larger wildfires that burned in 2017 were closer to human habitation than in previous years.

1 Northwest Interagency Coordination Center. Feb 26, 2018. Northwest Annual Fire Report 2017. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2017_NWCC_Annual_Fire_Report_FINAL.pdf (Accessed November 2018).

Figure 1. Total wildfire acres burned in Oregon, 2008-2017.[2]



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Acres Burned	136,572	130,654	93,731	285,712	1,256,049	350,786	984,629	685,809	219,509	714,520

1.2 Transport Weather Conditions

According to the 2017 Northwest Annual Fire Report,[3] while winter and spring of 2016-2017 brought cold temperatures and higher than average accumulation of precipitation to the Pacific Northwest and the Northern Rockies, temperatures across the northwest geographic area began warming above average in spring of 2017 even as precipitation continued across much of the area. Precipitation declined significantly after mid-June, but temperature continued to climb across the geographic area.

Temperatures continued to warm through July and peaked in August. July temperatures were well above average for much of the western US while August of 2017 proved to be the warmest August on record for a number of climate zones in Oregon, Washington and northern California (see Figure 2). Multiple records were set for consistent warm temperatures. Parts of the region endured over 50 days before rain returned in early August. Another dry spell lasting a month followed on its heels.

[2] https://www.nifc.gov/fireInfo/fireInfo_statistics.html (Accessed 4/2/19)
[3] Northwest Interagency Coordination Center. Feb 26, 2018. Northwest Annual Fire Report 2017. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2017_NWCC_Annual_Fire_Report_FINAL.pdf (Accessed November 2018).

Figure 2. Temperatures in the Northwest during the 2017 wildfire season were significantly higher than normal. (A) PNW average temperature and (B) by geography.

Figure 2A.

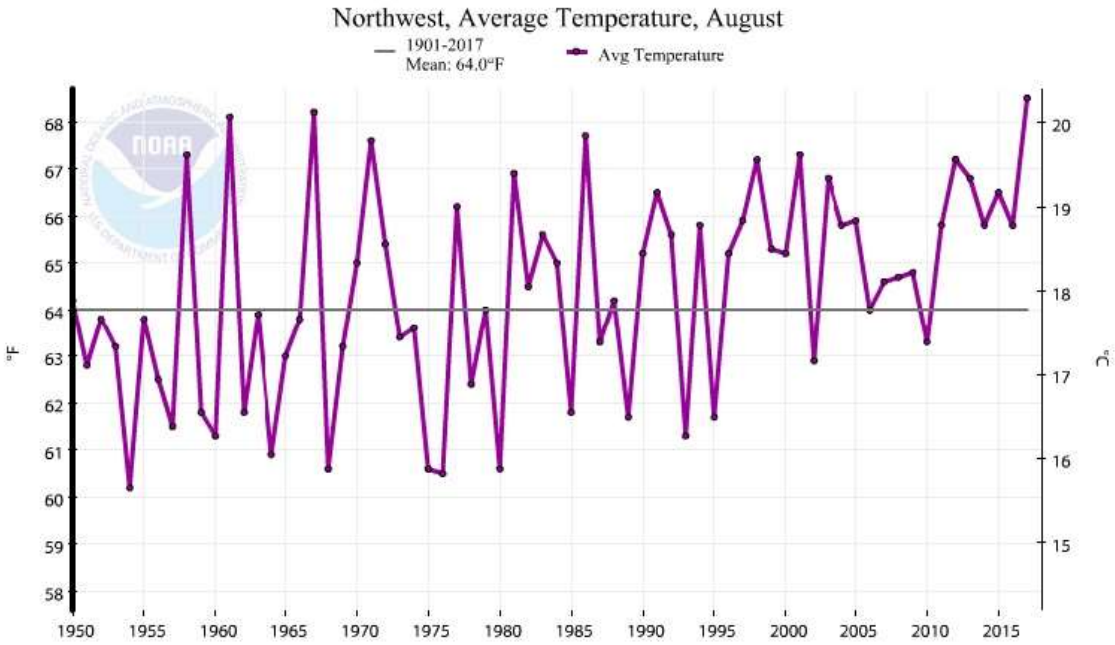


Figure 12B.

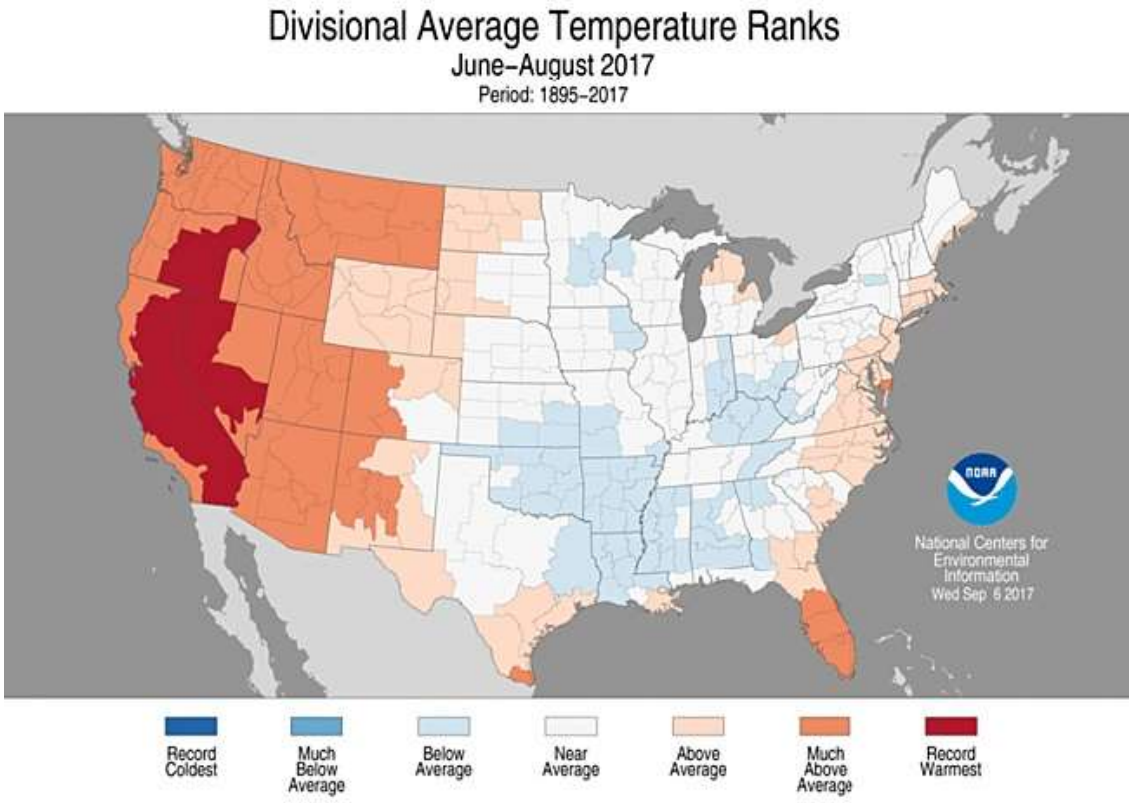
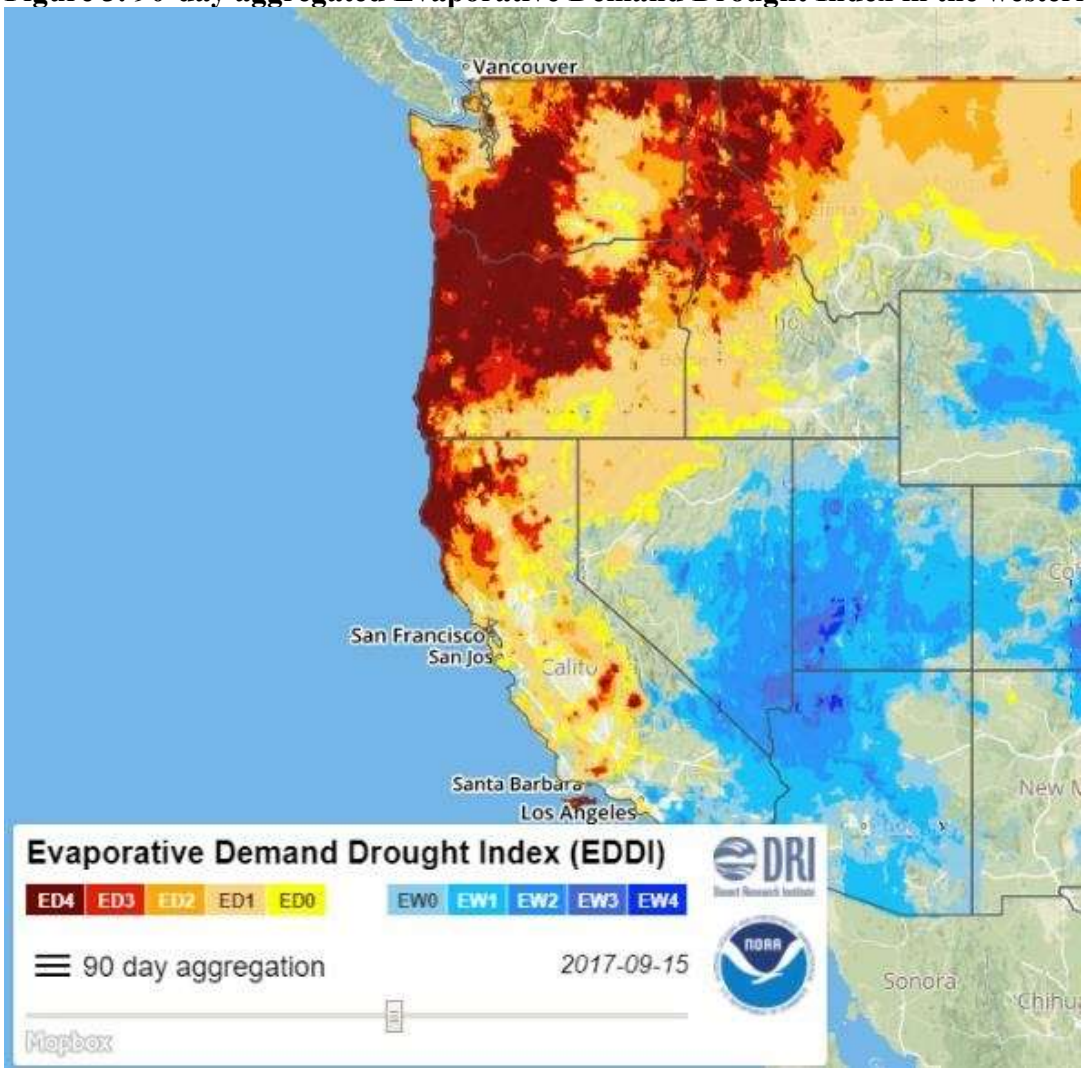


Figure 3. 90-day aggregated Evaporative Demand Drought Index in the western states.



The upward change in temperature followed by the lack of precipitation after June created a "flash drought" condition. Flash droughts develop very quickly with little or no warning that a drought is developing. The wet winter and spring combined with warm temperatures resulted in significant plant growth but as the precipitation dwindled and temperatures began to climb, the atmospheric demand for water resulted in very high evapotranspiration. Drought stress set in for live fuels such as trees and shrubs as well as dead material. Over the three-month period between June and September, the equivalent of extreme drought developed over the forests of the Northwest (see Figure 3). In early and mid-August, especially during Aug 9-11, 2017, a period of extreme heat with temperatures in the 100s was followed by storms and lightening, which caused the vast bulk of the August and September fires that year.

Temperatures fell back to normal or below in mid-September when a wet cold front brought a strong frontal system to the region. Cold, moist air lingered over the region, bringing rainfall substantial enough to put a stop to new large fire outbreaks and halt the growth of existing fires. Fire season was effectively ended by this event.

1.3 Source Area and Affected Region

Klamath Falls

Klamath Falls is located in south central Oregon at an elevation of 4,105 feet. The City of Klamath Falls serves as an important commercial center for south central Oregon. The Klamath Basin is a relatively flat area of an old high elevation lakebed that is drained by the Klamath River. Occasional hills and a system of elongated ridges confine the basin and the greater Klamath Falls area to the east and west. Most of the Klamath Falls residential area, especially the south suburban area, is located on the lower elevation area. Because of these features, Klamath Falls can experience very strong and shallow nighttime inversions that break up with daytime solar heating. In the wintertime, frigid arctic air masses frequently move down Upper Klamath Lake and invade the Klamath Basin. Temperatures can remain well below freezing for several weeks at a time. Under these conditions, these strong inversions occur over the Klamath Basin concentrating emissions in the south suburban area of Klamath Falls.

In 1987, Klamath Falls was designated a nonattainment area by the Environmental Protection Agency for PM10 – particulate matter 10 microns and smaller. A PM10 attainment plan was developed for the Klamath Falls Urban Growth Boundary by 1991, however, at that time the area still had not met the standard. DEQ subsequently revised the PM10 plan and submitted an addendum to EPA in 1995. EPA approved both the attainment plan and the addendum on April 14, 1997. In 2002, DEQ submitted a maintenance plan for PM10. EPA approved the PM10 maintenance plan and Klamath Falls was redesignated to attainment for PM10 on October 21, 2003. Both the attainment plan and maintenance plan included a key strategy of a mandatory woodstove curtailment program and a large woodstove change-out program. This was accomplished through citizen involvement in Klamath Falls and the citizenry addressing it at a local level through both ordinance and education of neighbor-to-neighbor. As a result, the area met and continues to meet the PM10 standards.

In 1997, EPA revised the particulate standard to include PM2.5 and established a daily standard of 65 µg/m3. The original PM10 strategies included in the attainment plan were so successful in maintaining clean air that Klamath Falls met the fine particulate (PM2.5) standard. By 2006, however, EPA modified the PM2.5 standard again based on the latest health effects data, lowering it to 35 µg/m3. Klamath Falls has faced challenges in meeting this daily PM2.5 standard. DEQ has measured particulate at the same location in the Klamath Falls UGB (Peterson School on Clinton Street) since 1996 and conducted numerous saturation surveys to confirm Peterson School is still the appropriate location for the monitor.

Portions of Klamath Falls in Klamath County were designated as the Klamath Falls PM2.5 nonattainment area in 2009 (based on 2006 data), with an attainment date on December 31, 2015. Klamath Falls was classified as moderate for PM2.5 on June 2, 2014 (79 FR 31566). In June 2016, EPA approved a finding of attainment and clean data determination for Klamath Falls, based on data from 2012-2014. Monitor values during the 2017 wildfire seasons that meet the criteria for exceptional events must be excluded for Klamath Falls to be redesignated as an attainment area and demonstrate continued ability to meet the NAAQS for PM2.5.

For Klamath Falls, 2017 wildfire smoke events were primarily from fires in the Umpqua North Complex and the High Cascades Complex, which were northwest of Klamath Falls (Figure 4). Southern fires in Oregon (Miller Complex, Chetco Bar) and California (Eclipse Complex, Salmon-August Complex) also increased PM levels over Klamath Falls.

Oakridge[4]

The Oakridge community in Lane County, Oregon, has steadily improved air quality over the past 25+ years. Oakridge is a forest-oriented community (population 3,240 as of July 2015) in a valley of the Middle Fork Willamette River in the foothills of the Cascade Mountains about 45 miles southeast of Eugene-Springfield. Many of the homes are heated by wood as the primary or secondary heat source, or even sole source in some cases. As a result, the major contributor to the historical particulate air pollution has been home wood heating, especially on stagnant winter days when temperature inversions form over the small valley.

The Lane Regional Air Protection Agency has been monitoring in Oakridge for inhalable particulate matter (PM10 – particles 10 microns and smaller) since 1988 and for respirable particulate matter (PM2.5 – particles 2.5 microns and smaller) since 1999. The U.S. Environmental Protection Agency designated Oakridge as a moderate PM10 nonattainment area in 1994. The City of Oakridge, LRAPA, and the Oregon Environmental Quality Commission adopted the Oakridge PM10 attainment strategy in 1996 and submitted to EPA as part of the State Implementation Plan. EPA approved the plan in 1999. The Oakridge PM10 strategy focused primarily on control of residential wood combustion. The attainment strategy was successful in achieving the PM10 standards in Oakridge on schedule. In 2001, EPA published a finding of attainment for the Oakridge PM10 area.

The 1996 Oakridge PM10 attainment plan was successful in not only meeting the PM10 standards on schedule, but also meeting the initial national PM2.5 standard of 65 micrograms per cubic meter (µg/m3) adopted by EPA in 1997. EPA adopted a more protective 24-hour national PM2.5 health standard of 35 µg/m3 in 2006, and Oakridge was identified as a PM2.5 nonattainment area by Oregon and EPA in 2009. LRAPA, the City of Oakridge, and other community stakeholders developed a comprehensive Oakridge PM2.5 attainment plan in 2012, and then adopted additional control strategies in the Updated Oakridge PM2.5 2016 Attainment Plan ("Plan"). The LRAPA Board of Directors adopted the Plan in November 2016 and Oregon EQC adopted it in January 2017. Implementation of the Plan resulted in attainment of the 35 µg/m3 PM2.5 health standard in 2014-2016. EPA approved the Plan and made a finding of attainment for the Oakridge PM2.5 area in February 2018.

In 2017, wildfire smoke events primarily came from fires in the Umpqua North Complex and High Cascades Complex. Smoke from northern fires (Horse Creek Complex, and Willamette forest fires) also contributed to elevated PM (Figure 4).

[4] LRAPA, April 15, 2019. Email communication with Lance Giles and Merlyn Hough. Primarily sourced from: http://www.lrapa.org/DocumentCenter/View/2108/Updated-Oakridge-Westfir-PM25-Attainment-Plan-EQC?bidId=.

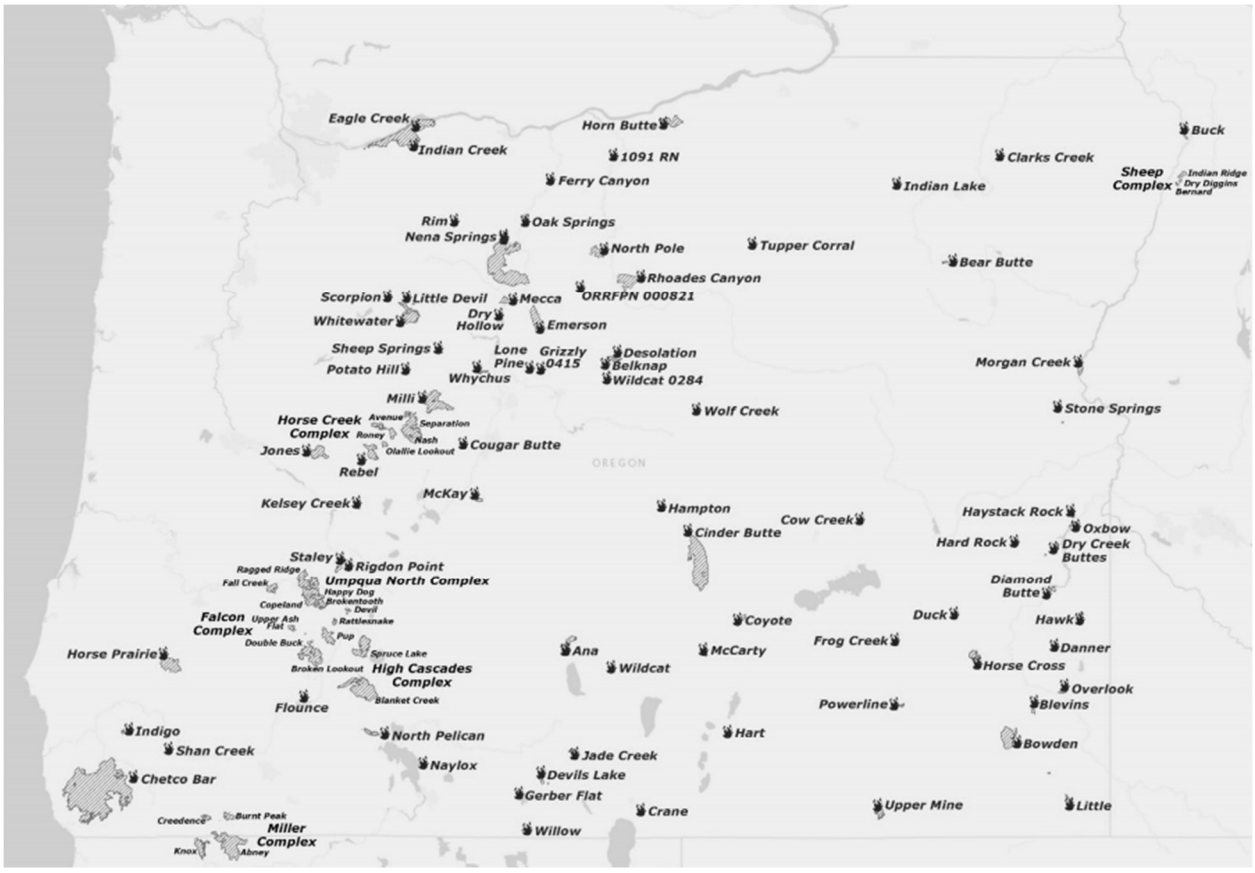


Figure 4. Map of 2017 Oregon large wildfires.[5]

1.3.1 Umpqua North and High Cascades Fire Complexes

Umpqua National Forest is located to the NW and NNW of Klamath Falls, and includes areas popular for recreational uses, tourism, and wilderness. For the 2017 fire season, out of 131 fires, the USDA Forest Service determined 115 were caused by lightning and 16 by humans.[6] However, lightning-caused fires burned 64,072 acres out of the 64,074 total acres burned in the 2017 fire season in the Umpqua National Forest area. By August 14, Umpqua North Complex fires Happy Dog and Fall Creek were major priorities for the area. High Cascades Complex fires were combined for management purposes with some Umpqua fires at this time. On August 15, the national situation report listed the Umpqua North Complex as the nation's top-priority fire. Then the Chetco Bar fire near Brookings, Oregon, grew massively, and large fires in Montana also demanded attention. For the next several weeks, orders for personnel and equipment at fires across the West often went unfulfilled, and securing supervisory staff for crews and equipment was especially difficult. Parts of roads were closed down for over a month, even to firefighting traffic. By August 31, the fire complex had grown to over 25,000 acres and was 23

[5] Northwest Interagency Coordination Center. Feb 26, 2018. Northwest Annual Fire Report 2017. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2017_NWCC_Annual_Fire_Report_FINAL.pdf (Accessed November 2018). P. 21.

[6] USDA Forest Service Pacific Northwest Region. 2018. *Wildfires of 2017: Umpqua National Forest.*16 pp. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd584106.pdf (Accessed 2/12/2019)

percent contained. Thunderstorms in late August brought some rainfall to the area and cooler temperatures and higher humidity had begun to lower fire danger.

The fire complex continued to grow over the next week, reaching over 38,000 acres by September 6. Containment had increased to 32 percent. Storms went through the area September 6 and 7, and over 200 lightning strikes were recorded during those two days, but enough precipitation had also fallen to cause flash flood warnings in the area due to burned vegetation. Additional soldiers from Joint Base Lewis-McChord near Tacoma, WA, and others arrived at the Umpqua North Complex on September 8 to fight the fires. National Guard personnel were also activated. Several inches of rain in the following week effectively stopped the further spread of fires.

1.3.2 Willamette and Deschutes National Forest Fires (Horse Creek Complex, Jones fire)

The Jones fire and Horse Creek Complex of fires (Avenue, Roney, Separation, Nash, Olallie and Rebel) both started on August 10, 2017, caused by natural lightning strike in the Willamette National Forest area slightly to the north of the Oakridge monitor. The Milli Fire (in the Deschutes National Forest) started on August 11 and burned until September 24, 2017. The Horse Creek Complex was contained by September 27, 2017, while the Jones fire took until mid-October to contain. Together those fires burned over 75,000 acres in the 2017 fire season.

1.3.3 Methodology

Wind speed, wind direction and hourly PM2.5 readings were taken from monitors and plotted against the time of day for the previous evening and 24 hour period of the impacted day.

Satellite smoke images from MODIS Terra and MODIS Aqua satellites were examined for the day of the impacted monitor reading, for the central and southern Oregon region. These satellites tend to pass over the area that covers Klamath Falls and Oakridge from 10 am to 1 pm of each day.

HYSPLIT back trajectories were calculated in AirNow-Tech, using the PM2.5-88502 parameter and 1-hour duration. The date and time was set to the time of day where the monitor reading was at its peak. Heights were set at 50 m, 500m, and 1000 m to capture near ground and higher altitude wind transport, and the model was usually run for 8-24 hour. Our data show an approximately a one to three-hour delay for Klamath Falls and Oakridge monitors from the forest fire complexes in question for 2017. See Appendix A for more details.

1.3.4. Klamath Falls Monitor Impacted Days

The following paragraphs in this section describe the information from examining wind speed, wind direction, satellite smoke images from MODIS Terra and MODIS Aqua satellites, and PM2.5 readings at the Klamath Falls monitor and information from the HYSPLIT back trajectory analysis and/or wind roses where applicable.

8/17/17

Evening winds from the NW picked up in the evening of 8/16, raising PM2.5 concentrations overnight. Winds shifted from the south and wind speeds dropped from about midnight to 6 a.m. 8/17, lowering PM readings steadily throughout the early morning hours. Wind speeds picked up from the west in the mid-morning hours and PM dropped to low levels throughout late morning, midday and early afternoon hours. Wind speeds picked up around noon, winds shifted to be more from the north-northwest, peaking around 10 p.m. that evening, and PM levels started picking up as winds shifted from the NW. Clear indication that fires are to the NW and NNW.

Figure 5A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 5B shows the MODIS satellite data. Figures 5C and 5D show the HYSPLIT back trajectory and the wind rose at the monitor, respectively.

Figure 5A-D. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 8/17/17.

Figure 5A.

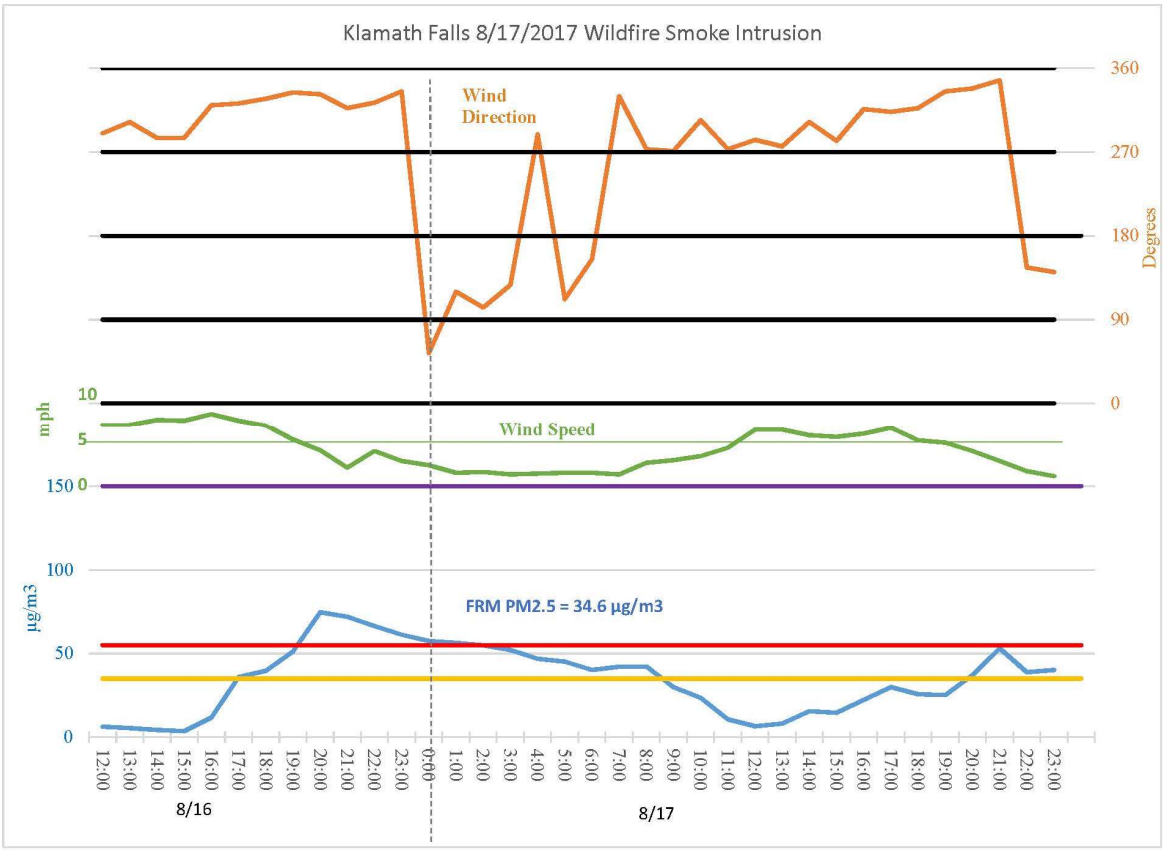


Figure 5B.

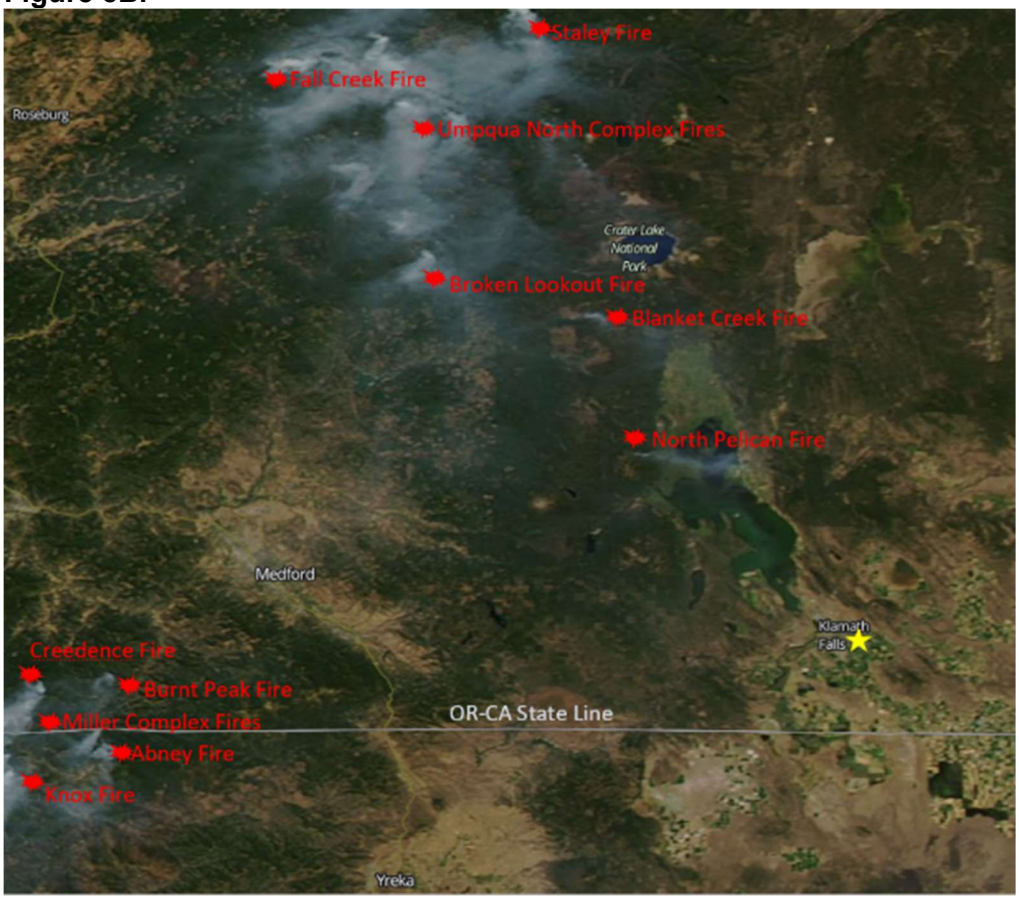


Figure 5C.

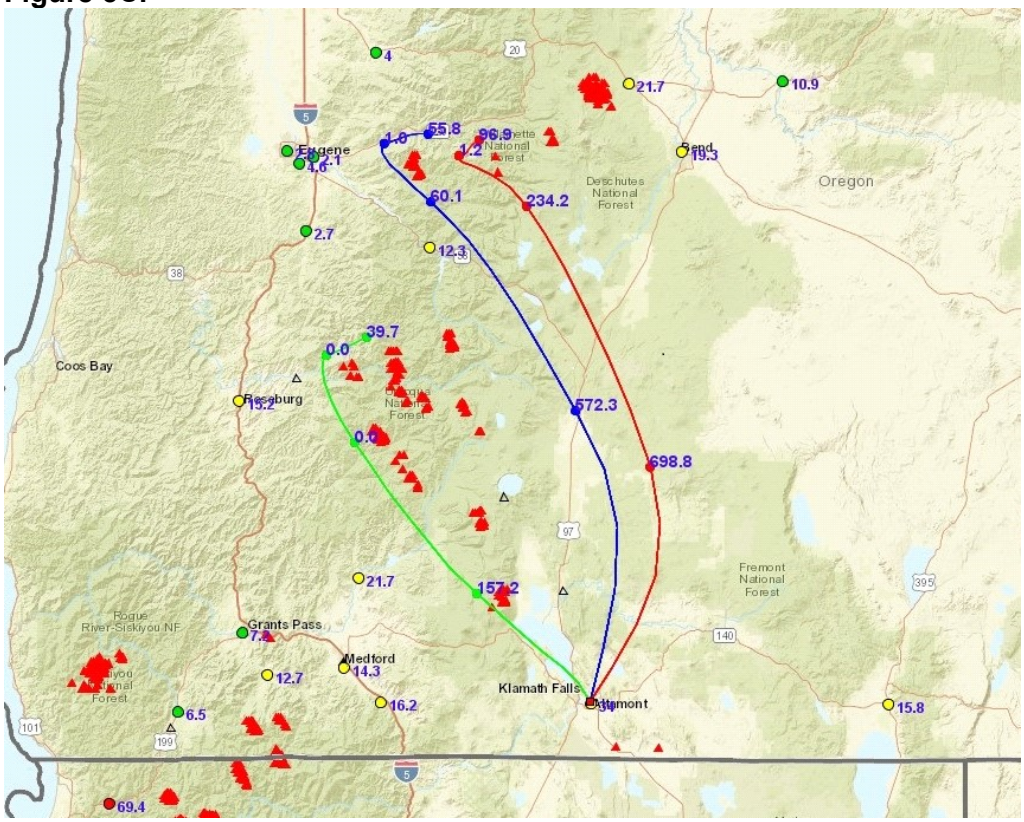
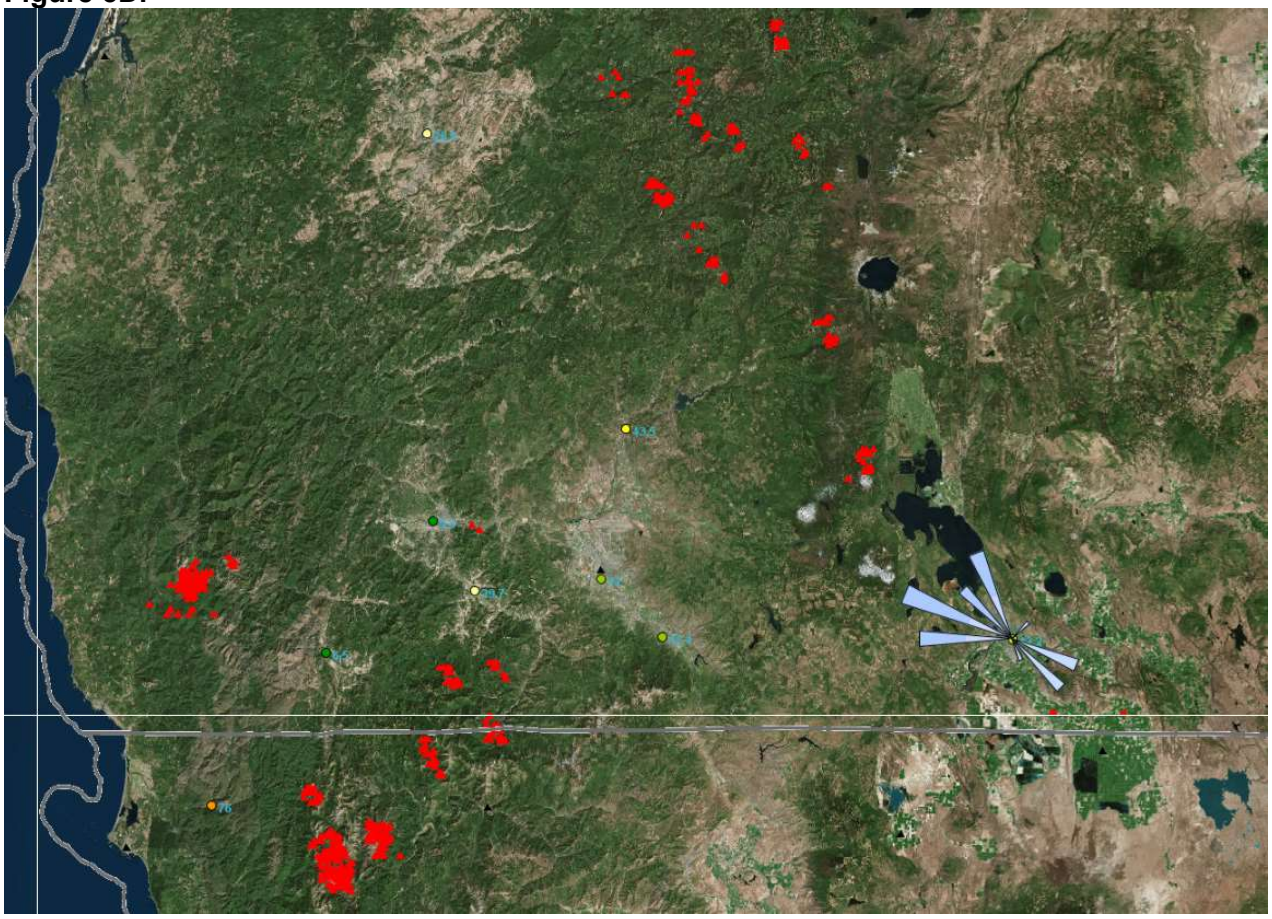


Figure 5D.



8/20/17

Winds from WNW shifted to NW about 3 p.m. 8/19, PM observed picking up by 4 p.m. and was extremely high at 5 p.m. This lasted for several hours. Wind speeds dropped after 8 p.m. and PM dropped throughout the evening and into the morning of 8/20. Wind speeds started picking up around 9 a.m. from the WNW and headed in NW and NNW by 1 p.m. that afternoon. PM starts to pick up around 1 p.m., accelerating at 6 p.m. and peaking around 8:30 p.m. Clear indication that fires are to the NW and NNW.

Figure 6A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 6B shows the MODIS satellite data. Figures 6C and 6D show the HYSPLIT back trajectory and the wind rose at the monitor, respectively. Note that while that HYSPLIT models the back trajectory as coming from further north, the satellite smoke image, time series, and wind rose show PM2.5 coming from the direction(s) of the Crater Lake and Umpqua North fires, as well as the Chetco Bar and other fires to the west.

Figure 6A-D. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 8/20/17.

Figure 6A.

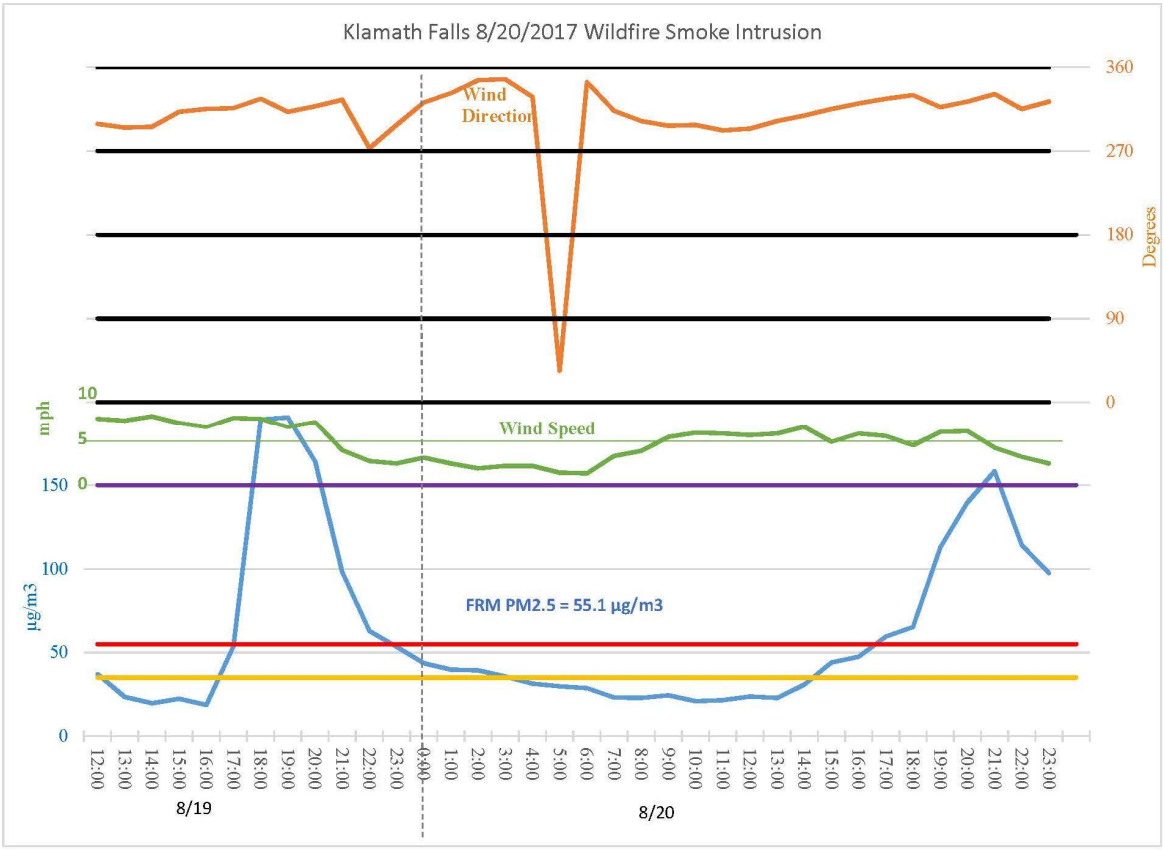


Figure 6B.

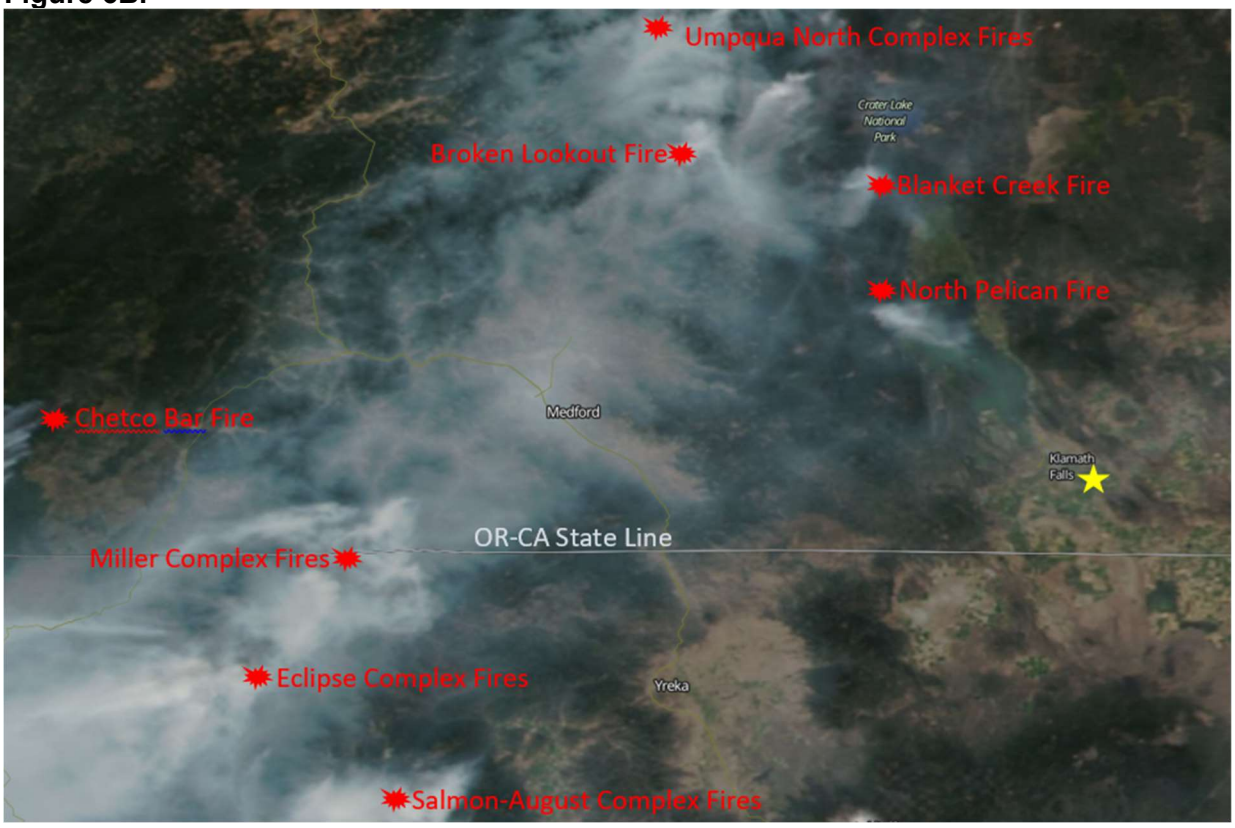


Figure 6C.

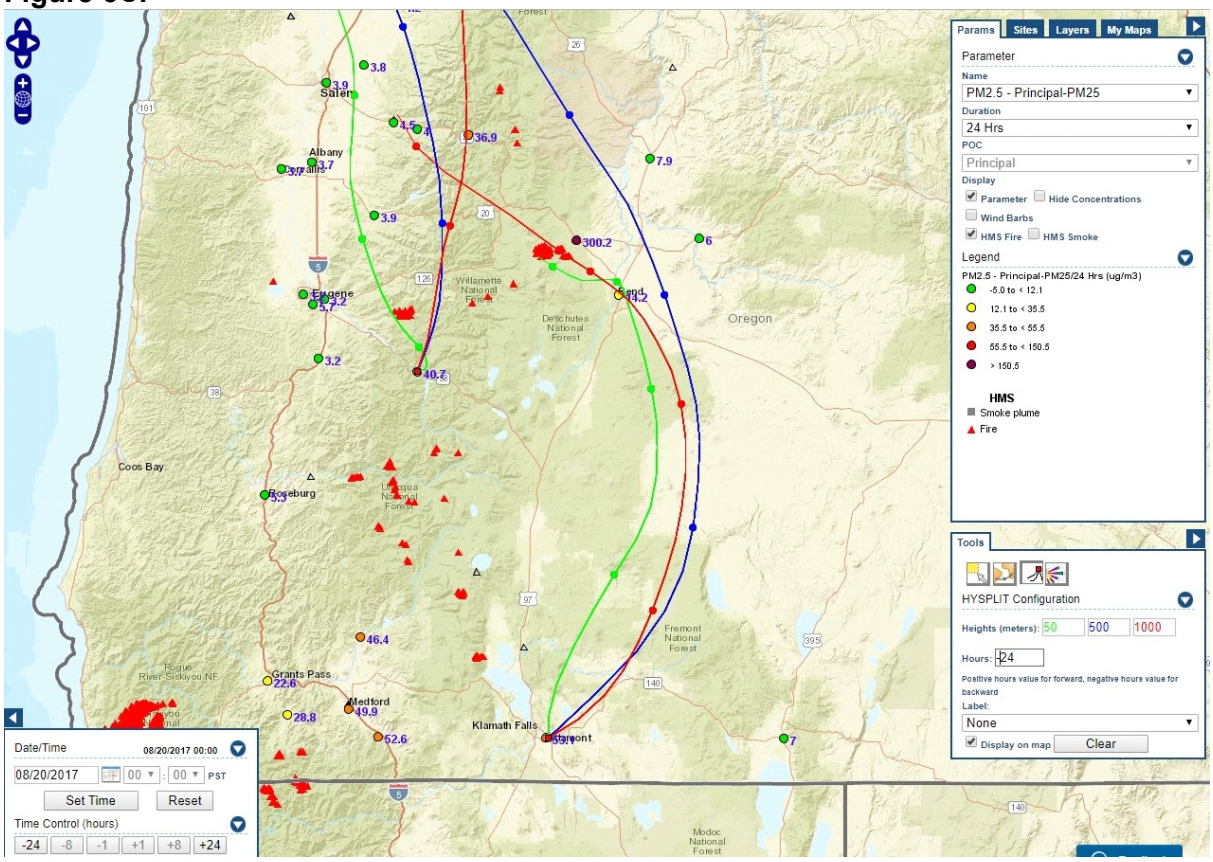
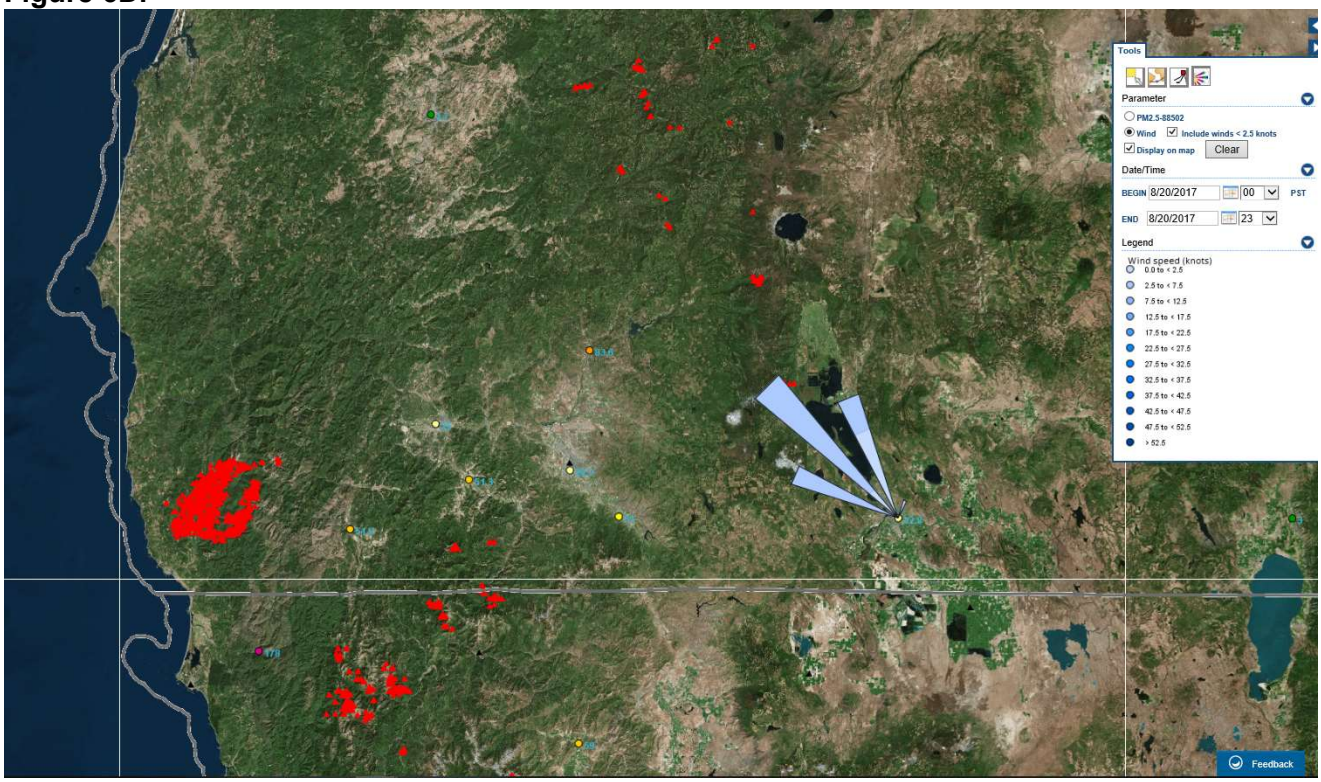


Figure 6D.


Tools
Parameter
PM2.5-88502
Wind
Include winds < 2.5 knots
Display on map
Clear
Date/Time
BEGIN 8/20/2017 00 PST
END 8/20/2017 23
Legend
Wind speed (knots)
0.0 to < 2.5
2.5 to < 7.5
7.5 to < 12.5
12.5 to < 17.5
17.5 to < 22.5
22.5 to < 27.5
27.5 to < 32.5
32.5 to < 37.5
37.5 to < 42.5
42.5 to < 47.5
47.5 to < 52.5
> 52.5
Feedback

8/23/17

Higher winds from the E evening of 8/22 cleared out PM and lasted throughout the day. Wind speeds slowed down throughout the day of 8/23, picking up slightly in the late afternoon. Winds shifted to the NW, NNW, and N by 1:30-2:00 p.m., and PM was heading up by 4 p.m. into nonattainment ranges throughout the rest of the evening. Clear indication that fires are to the NW and NNW.

Figure 7A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 7B shows the MODIS satellite data. Figures 7C and 7D show the HYSPLIT back trajectory and the wind rose at the monitor, respectively. Note that while that HYSPLIT models the back trajectory as coming from further north, the satellite smoke image, time series, and wind rose show PM2.5 coming from the direction(s) of the Crater Lake and Umpqua North fires, as well as the Chetco Bar and other fires to the west.

Figure 7A-D. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 8/23/17.

Figure 7A.

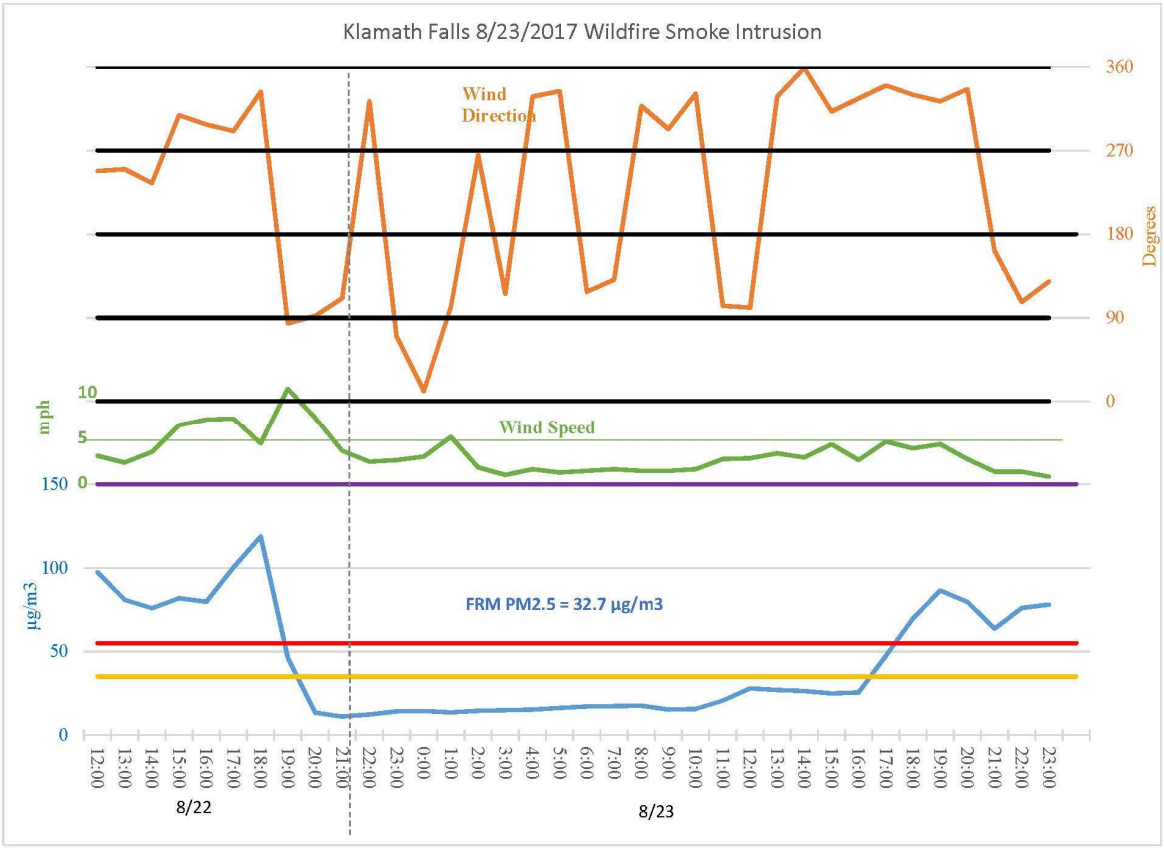


Figure 7 B.

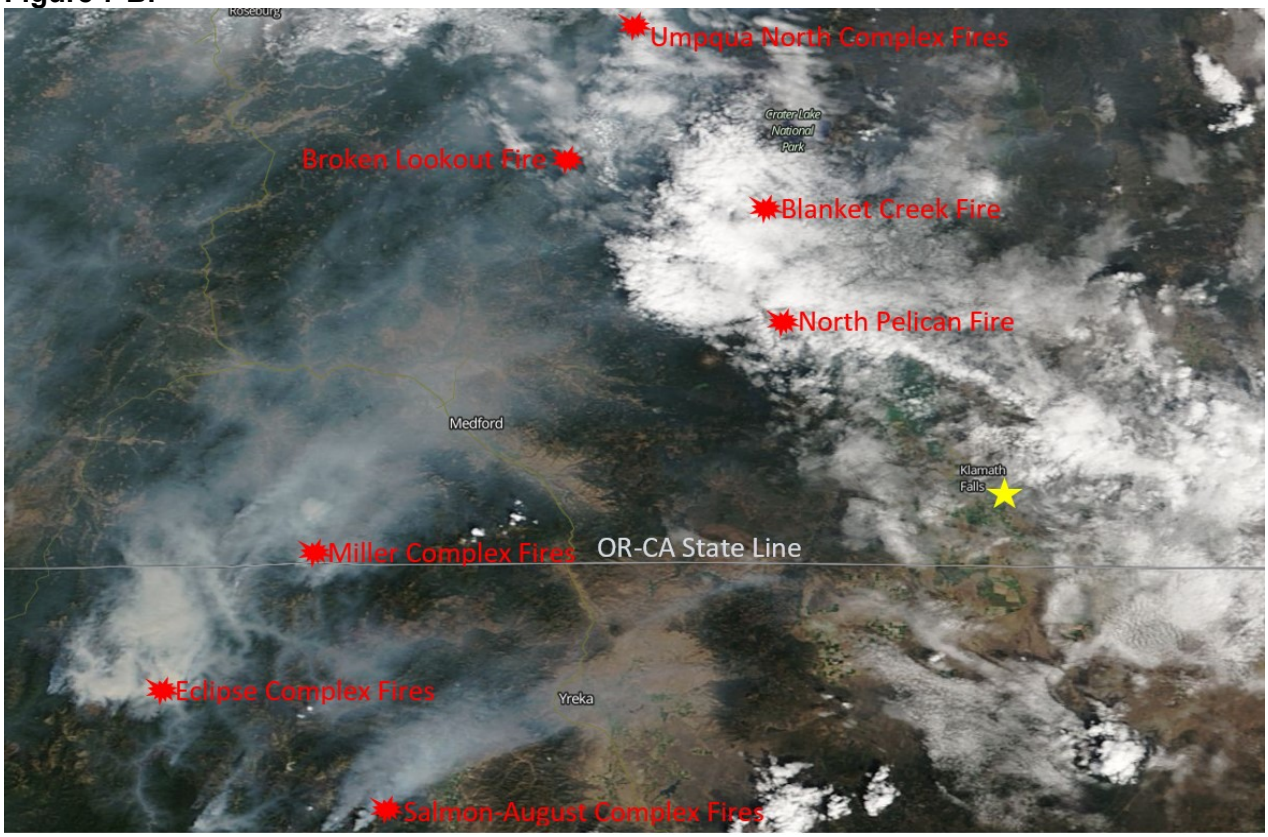


Figure 7C.

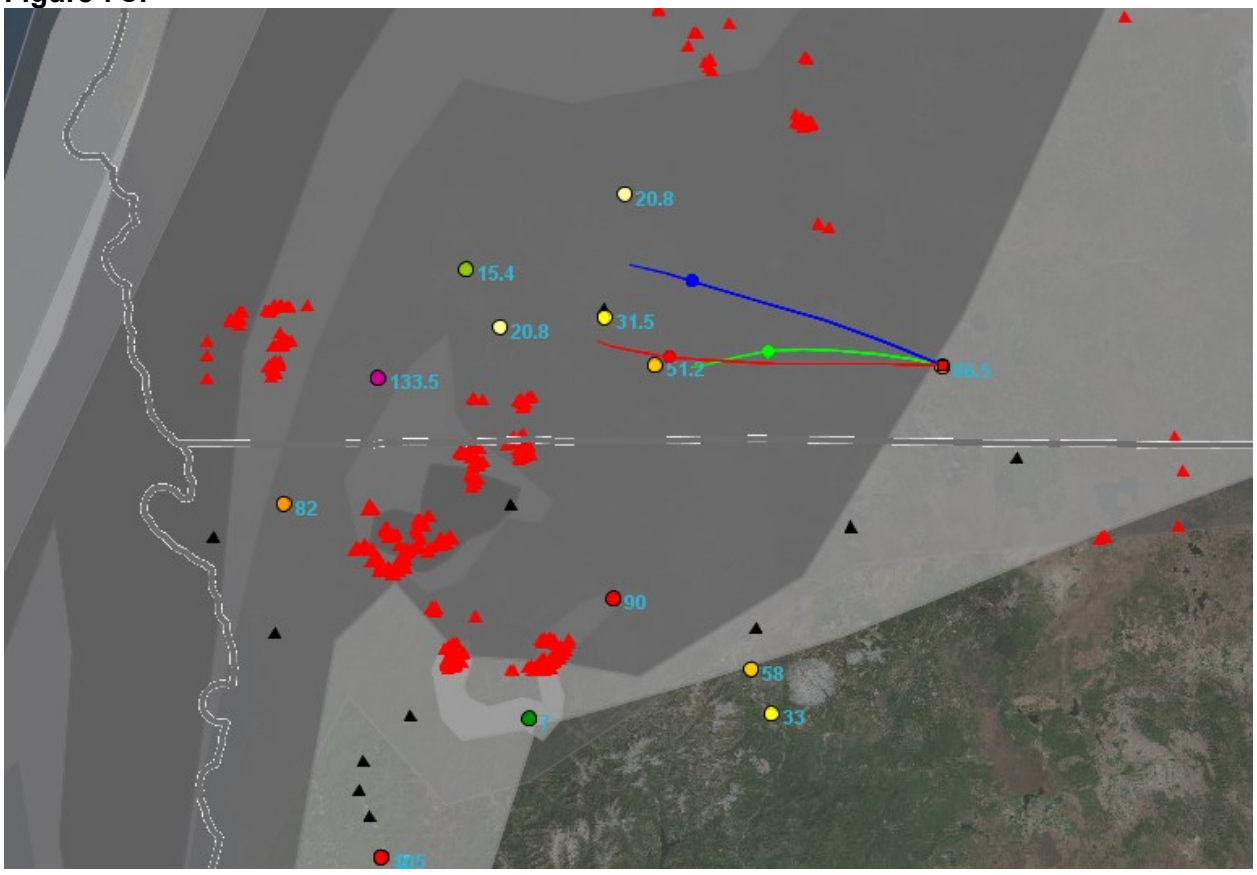
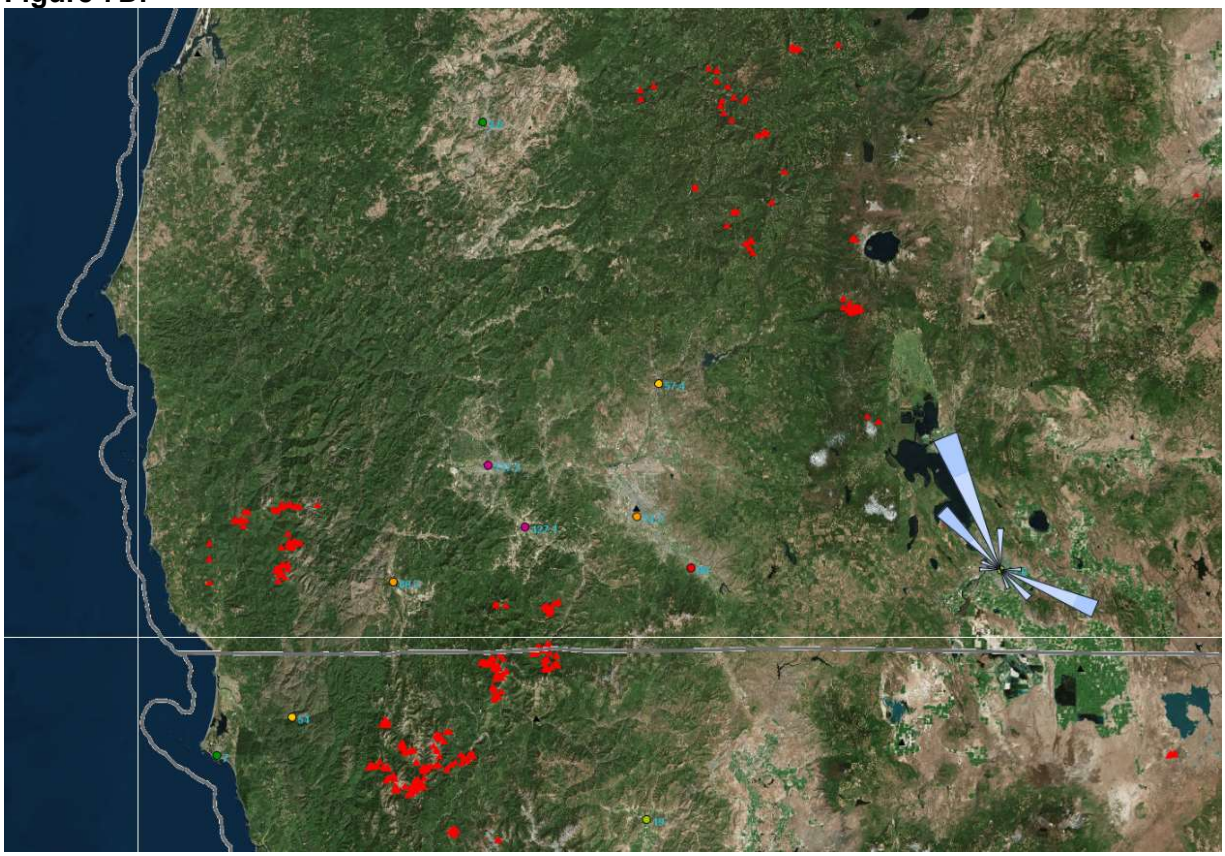


Figure 7D.



8/26/17

PM at medium-high levels starting midday the day before (8/25). Winds shift to NW by 4 p.m., PM starts to rise, heading into >35ug/m3 territory by 7 p.m., peaking at midnight (8/26) and falling steadily throughout the rest of the early morning and morning. PM falls to below significance about 11:15 a.m. PM stays low as winds shift to stay from the South and East for the rest of the day. Clear indication that fires are to the NW and NNW.

Figure 8A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 8B shows the MODIS satellite image. Figures 8C and 8D show the HYSPLIT back trajectory and the wind rose at the monitor, respectively.

Figure 8A-D. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 8/26/17.

Figure 8A.

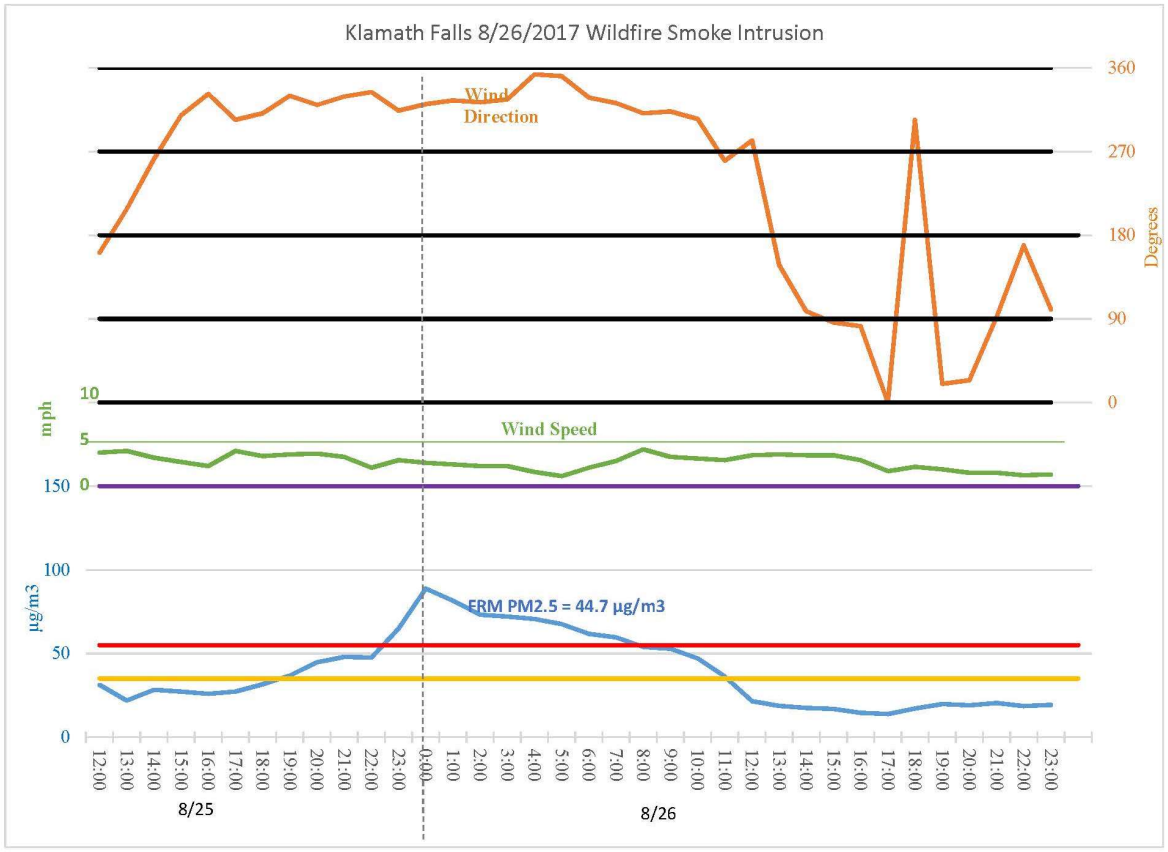


Figure 8B.

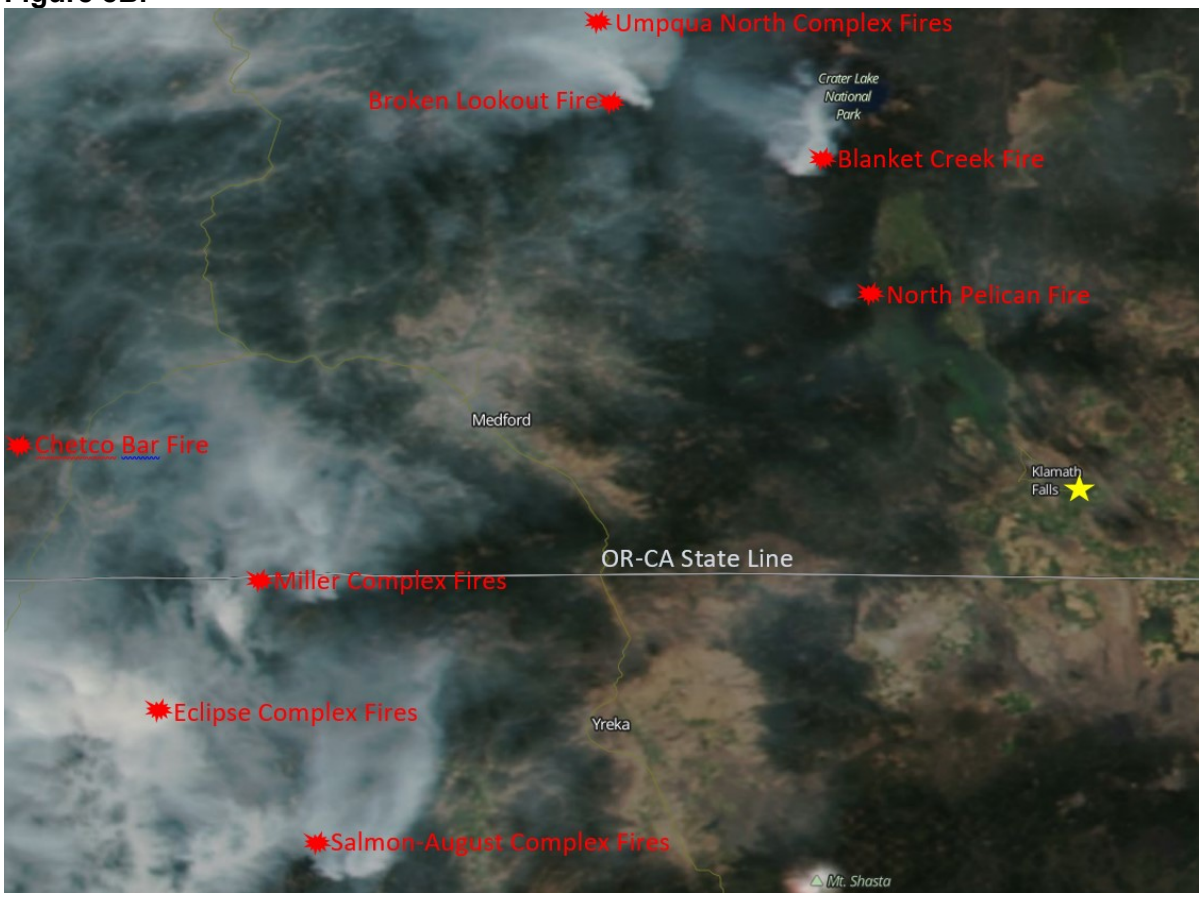


Figure 8C.

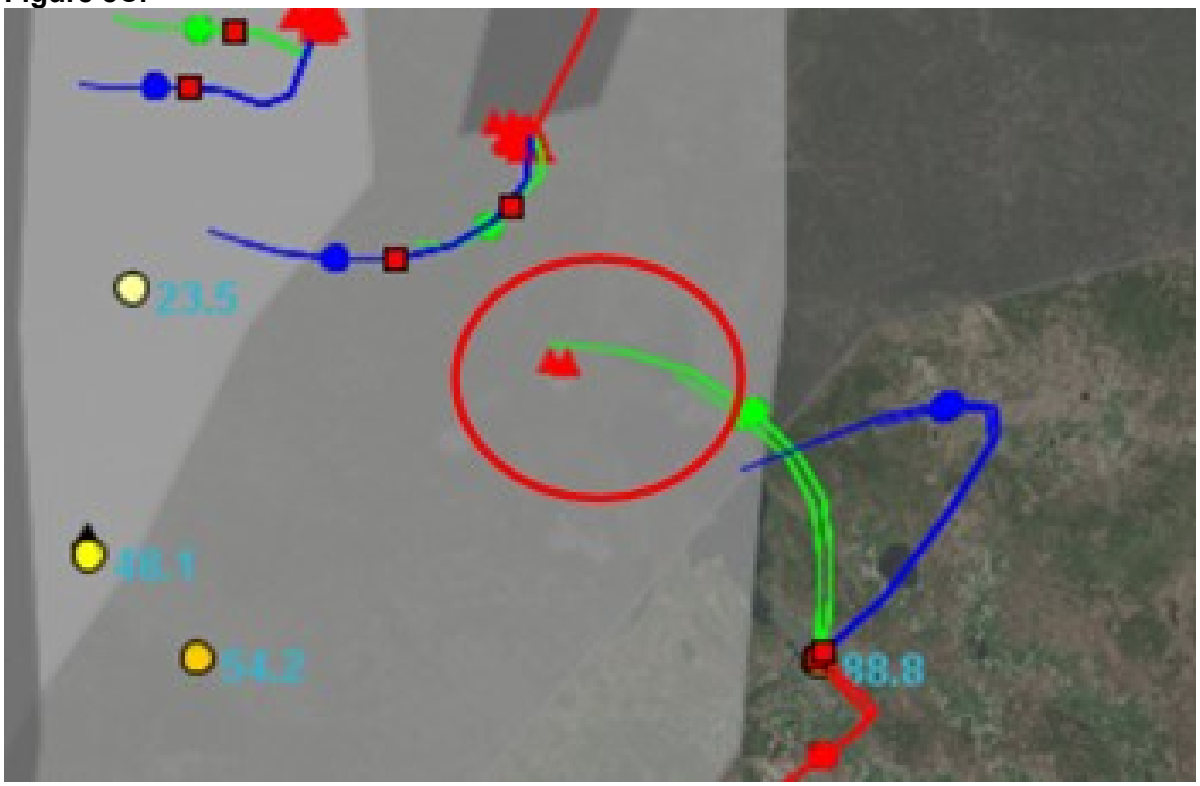
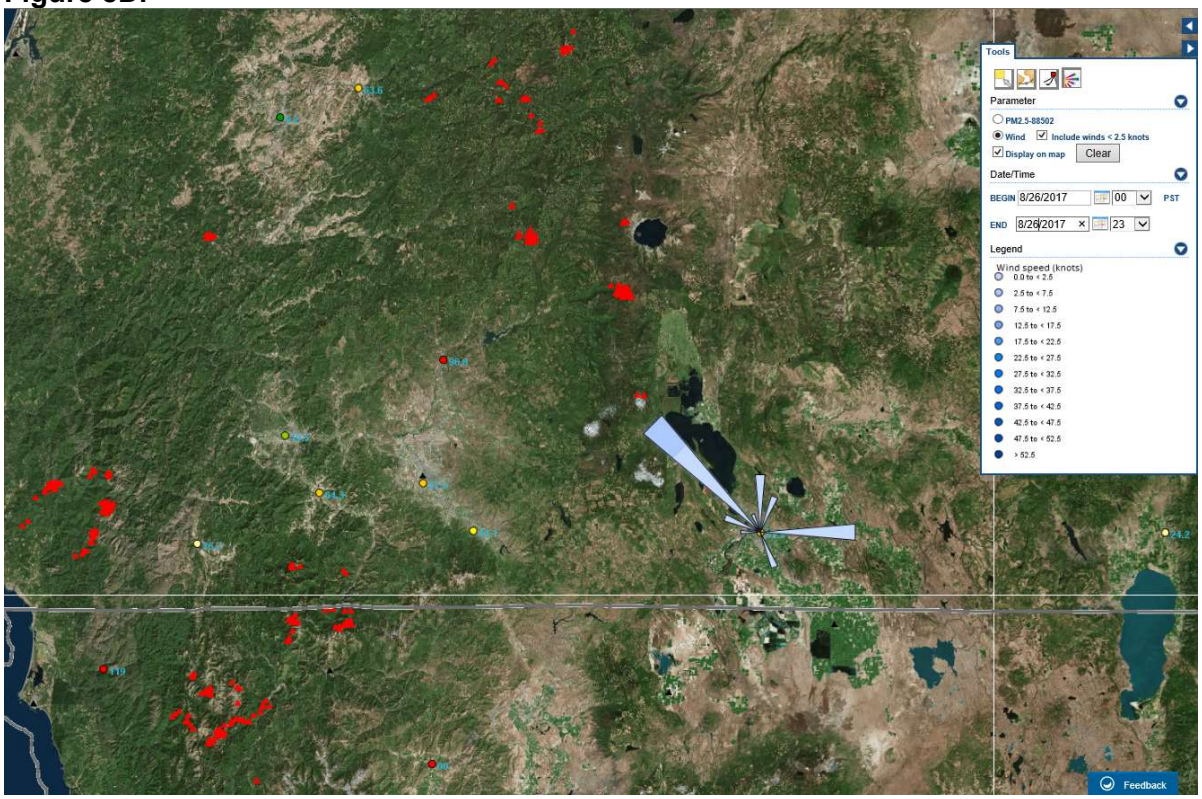


Figure 8D.


Tools
Parameter
PM2.5-88502
Wind
Include winds < 2.5 knots
Display on map
Clear
Date/Time
BEGIN 8/26/2017 00 PST
END 8/26/2017 23
Legend
Wind speed (knots)
0.0 to < 2.5
2.5 to < 7.5
7.5 to < 12.5
12.5 to < 17.5
17.5 to < 22.5
22.5 to < 27.5
27.5 to < 32.5
32.5 to < 37.5
37.5 to < 42.5
42.5 to < 47.5
47.5 to < 52.5
> 52.5
Feedback

8/29/17

PM rises start 5 p.m. on 8/28 after winds started coming from the NW around 4 p.m. PM levels stay high while winds bounce from WNW to NNE and back throughout the early morning hours and peak at 9 a.m. on 8/29. Winds shift directions to come from SSW, wind speed picks up starting around 10 a.m., and PM drops to very low levels for most of the early afternoon. Winds shift back to NW and PM levels rise again to above 50ug/m3 at about 6 p.m. that evening, and stay relatively high as wind speed slows down. Clear indication that fires are to NW and NNW.

Figure 9A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 9B shows the MODIS satellite image. Figures 9C and 9D show the wind rose at the monitor, for 8/28/17 and 8/29/17.

Figure 9A-D. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 8/29/17.

Figure 9A.

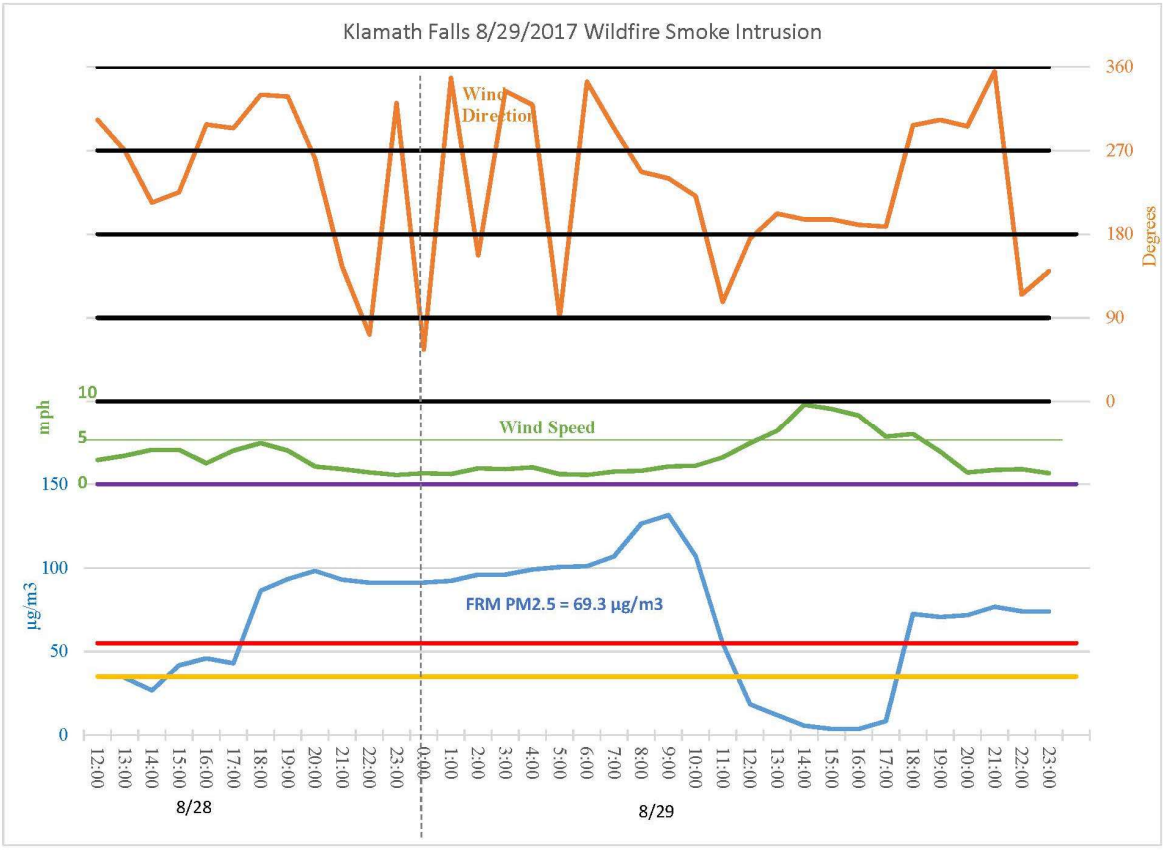


Figure 9B.

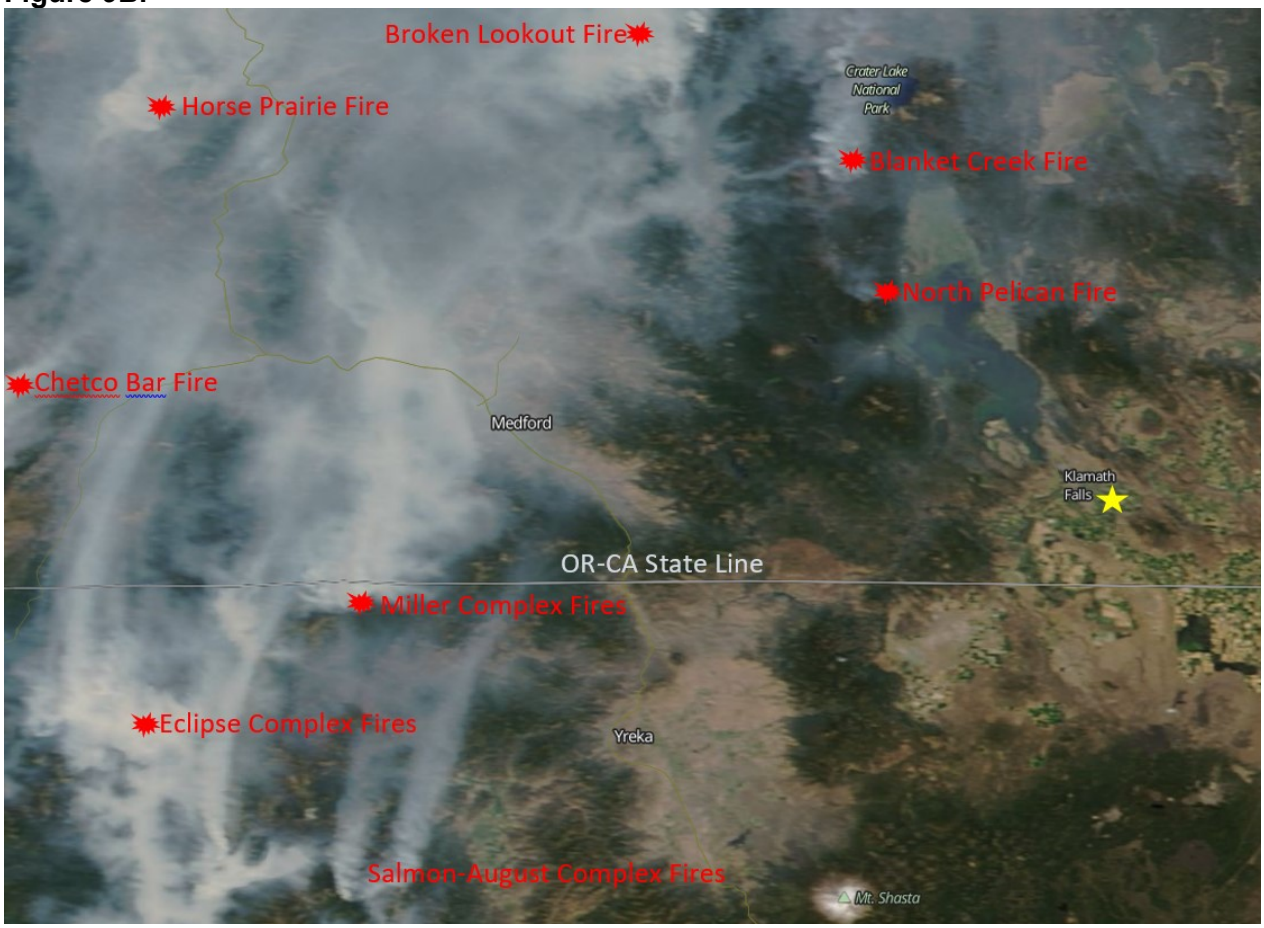


Figure 9C.

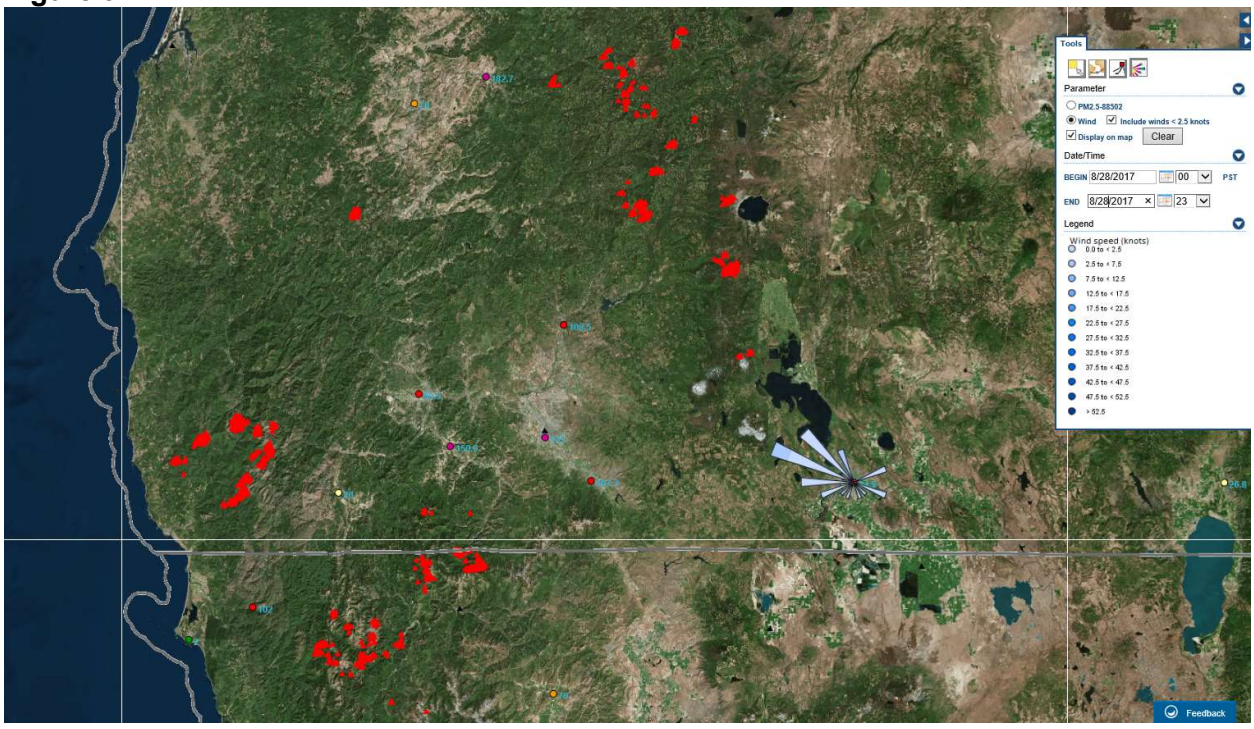
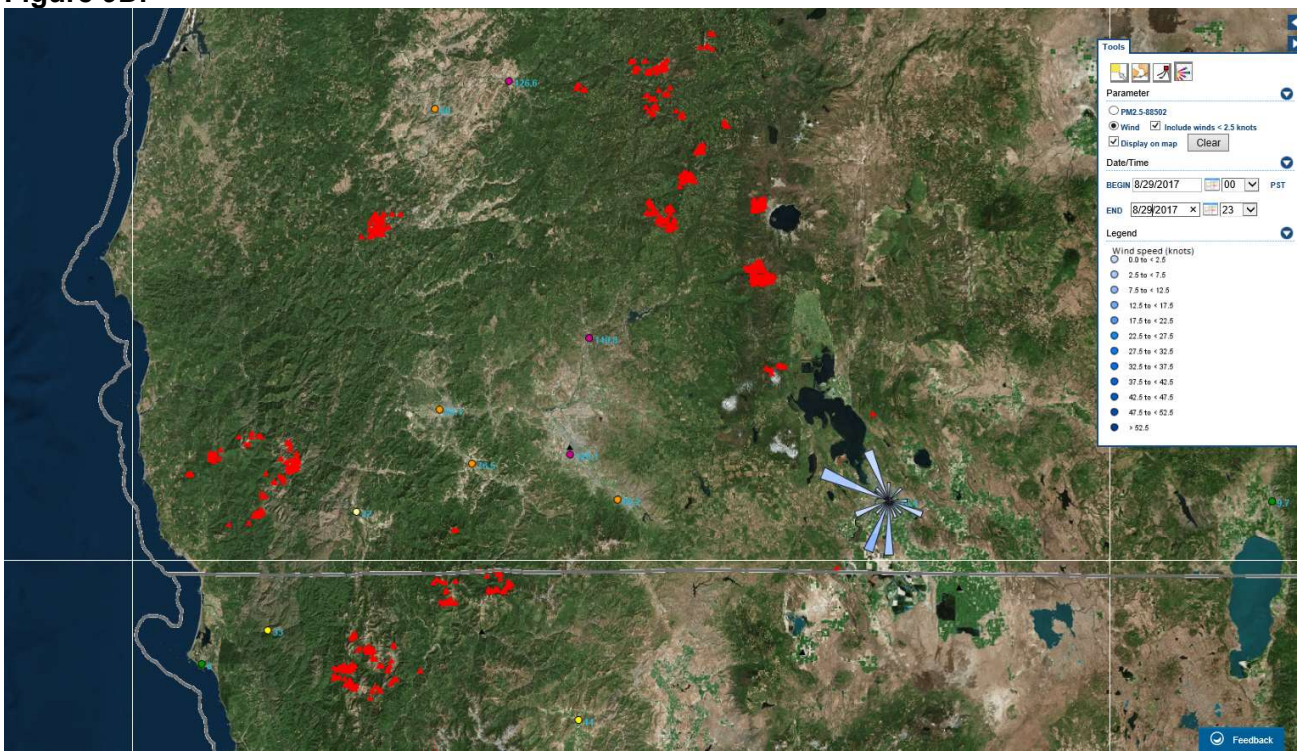


Figure 9D.


Tools
Parameter
PM2.5-88502
Wind
Include winds < 2.5 knots
Display on map
Clear
Date/Time
BEGIN 8/29/2017 00 PST
END 8/29/2017 23
Legend
Wind speed (knots)
0.0 to < 2.5
2.5 to < 7.5
7.5 to < 12.5
12.5 to < 17.5
17.5 to < 22.5
22.5 to < 27.5
27.5 to < 32.5
32.5 to < 37.5
37.5 to < 42.5
42.5 to < 47.5
47.5 to < 52.5
> 52.5
Feedback

9/1/17

PM peaks when winds start to come for NW and NNW directions, and fall to less than significant levels as winds start to come from WNW, N, or any other direction. Clear indication that fires are to the NW and NNW.

Figure 10A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 10B shows the MODIS satellite image. Figure 10C shows the HYSPLIT back trajectory and the wind rose at the monitor. Note that while that HYSPLIT models the back trajectory as coming from further north, the satellite smoke image, time series, and wind rose show PM2.5 coming from the direction(s) of the Crater Lake and Umpqua North fires, as well as the Chetco Bar and other fires to the west.

Figure 10A-C. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 9/1/17.

Figure 10A.

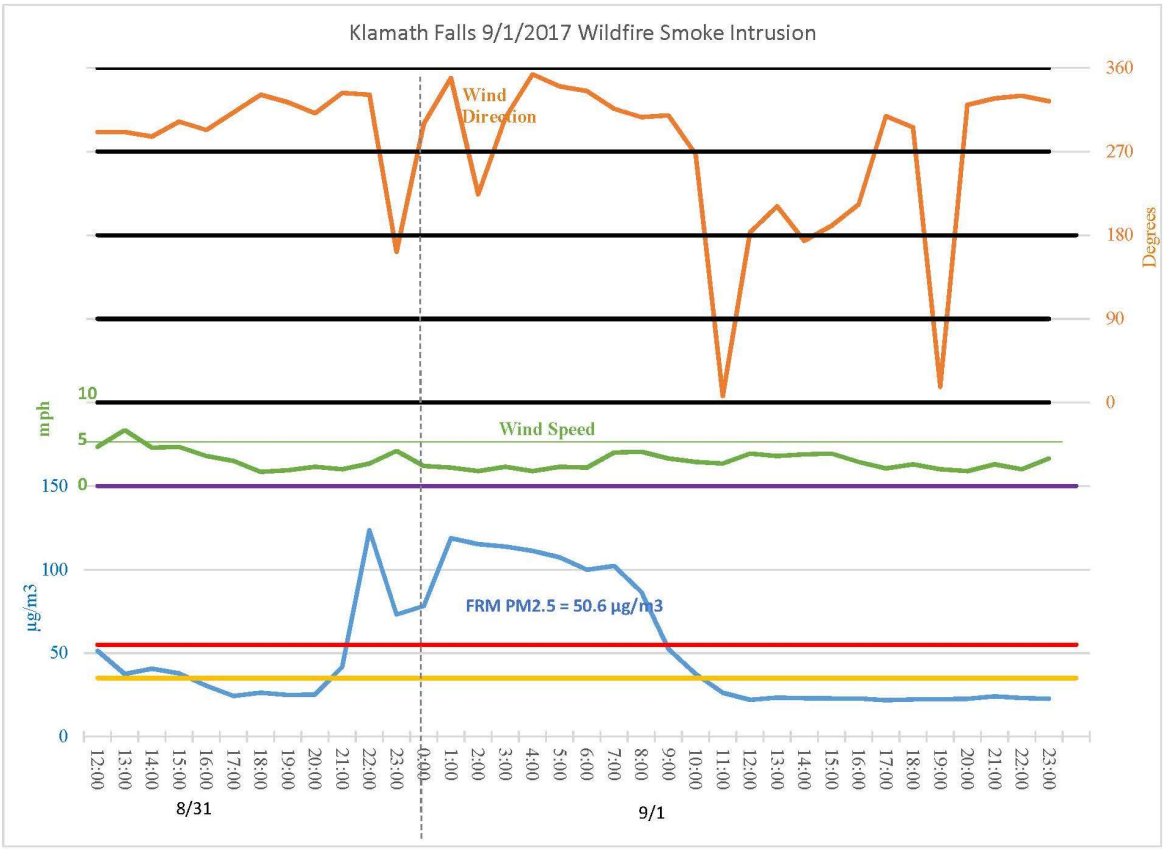


Figure 10B.

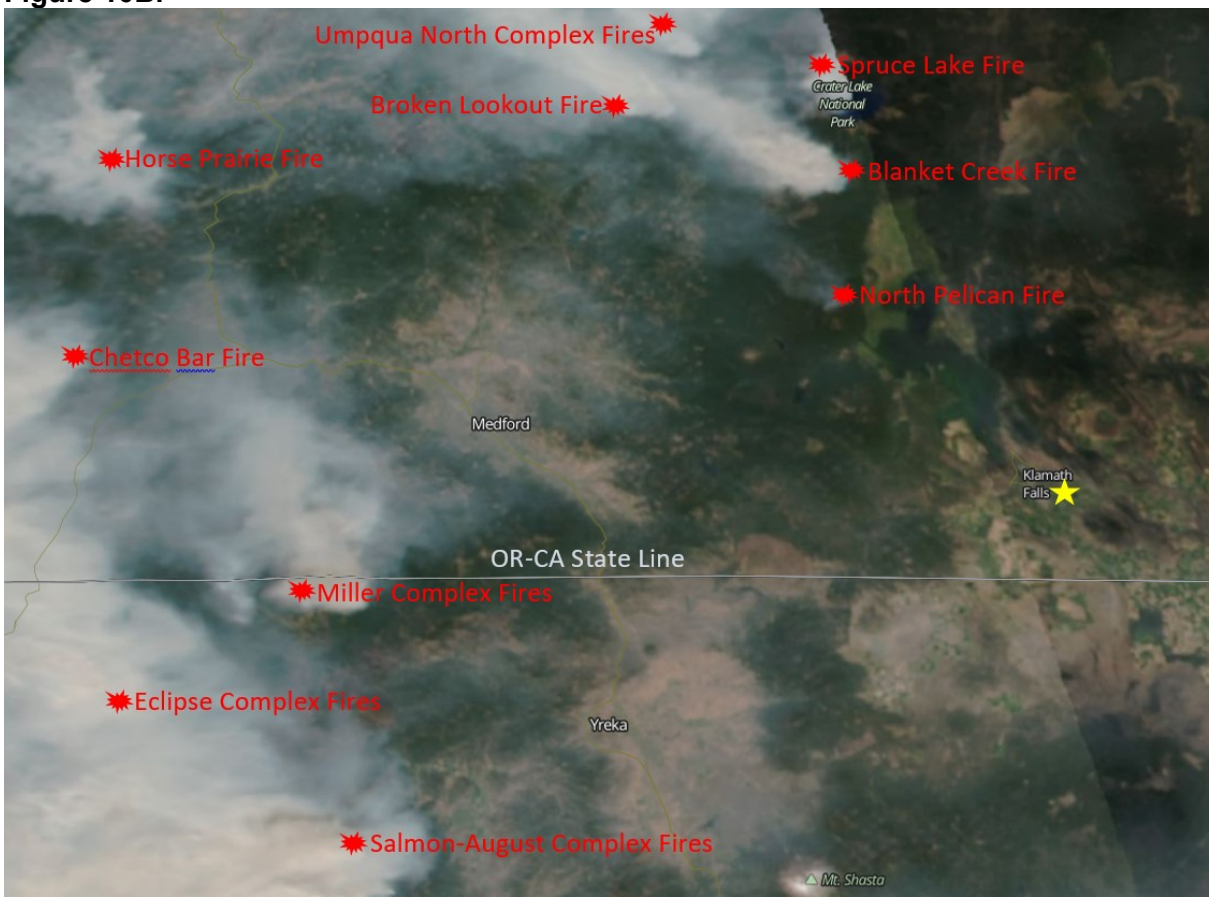
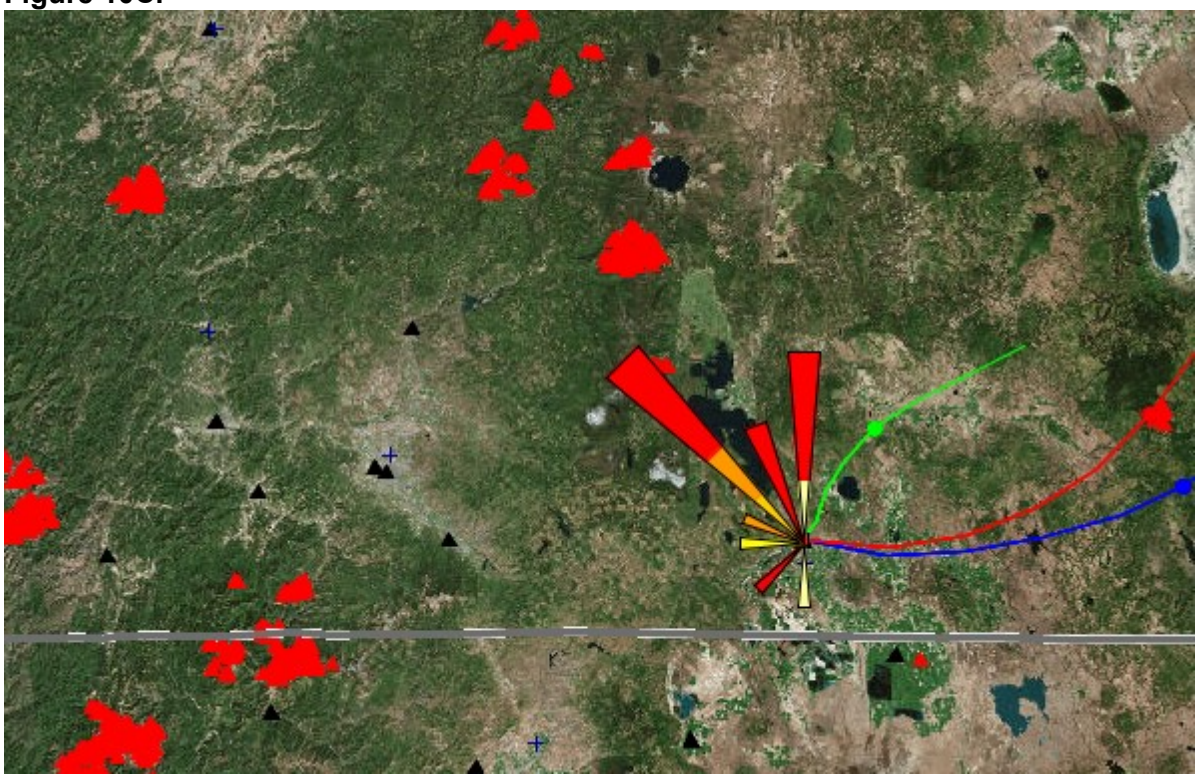


Figure 10C.



9/4/17

PM is extremely high 9/3 throughout the afternoon, dropping as wind speeds die down after 5 or 6 p.m. and wind directions change to being from the E and S, with intermittent gusts from the NW and N. PM levels stay high until 3 p.m. on 9/4 and winds stay in the NW range.

Figure 11A shows the time series (wind speed, wind direction, and hourly PM2.5 readings) at the Klamath Falls Peterson School monitor, while Figure 11B shows the MODIS satellite image. Figures 11C and 11D show the HYSPLIT back trajectory and the wind rose at the monitor, respectively.

Figure 11A-D. Time series, satellite smoke image, and modeling results for Klamath Falls Peterson School monitor, 9/4/17.

Figure 11A.

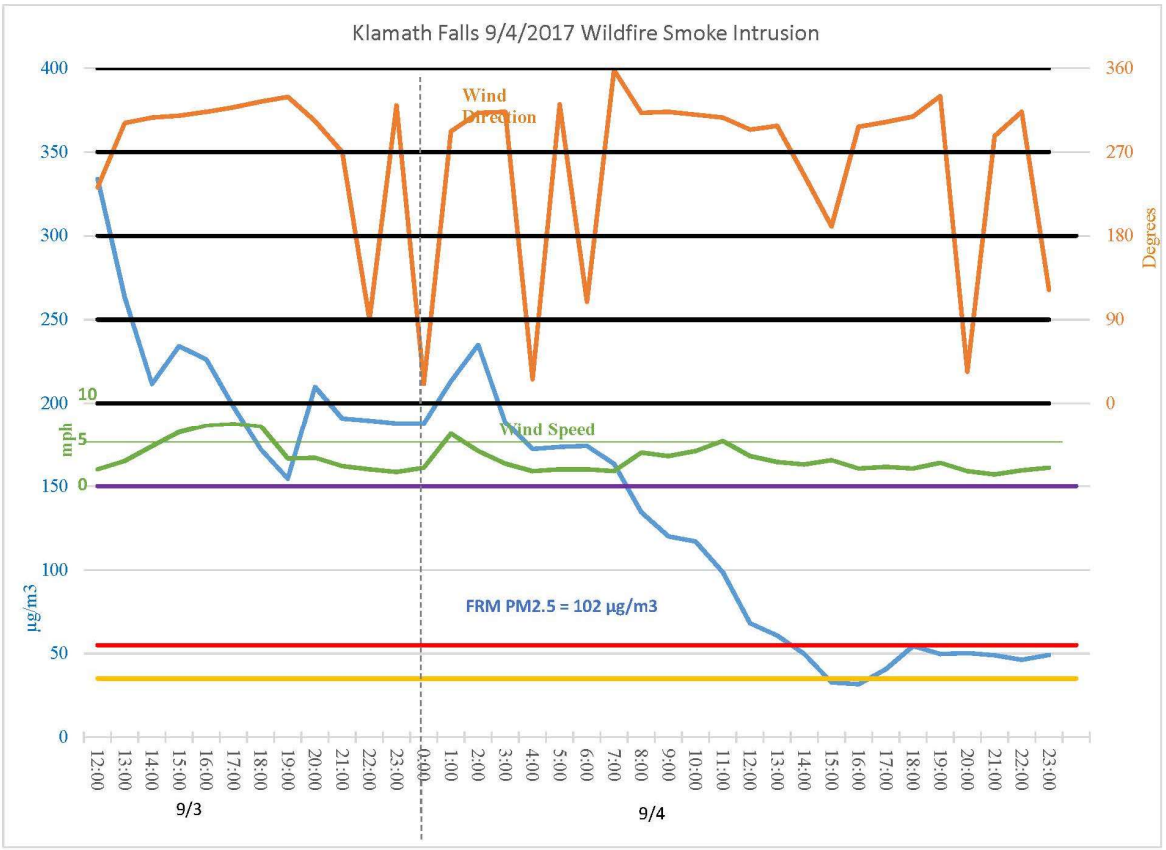


Figure 11B.

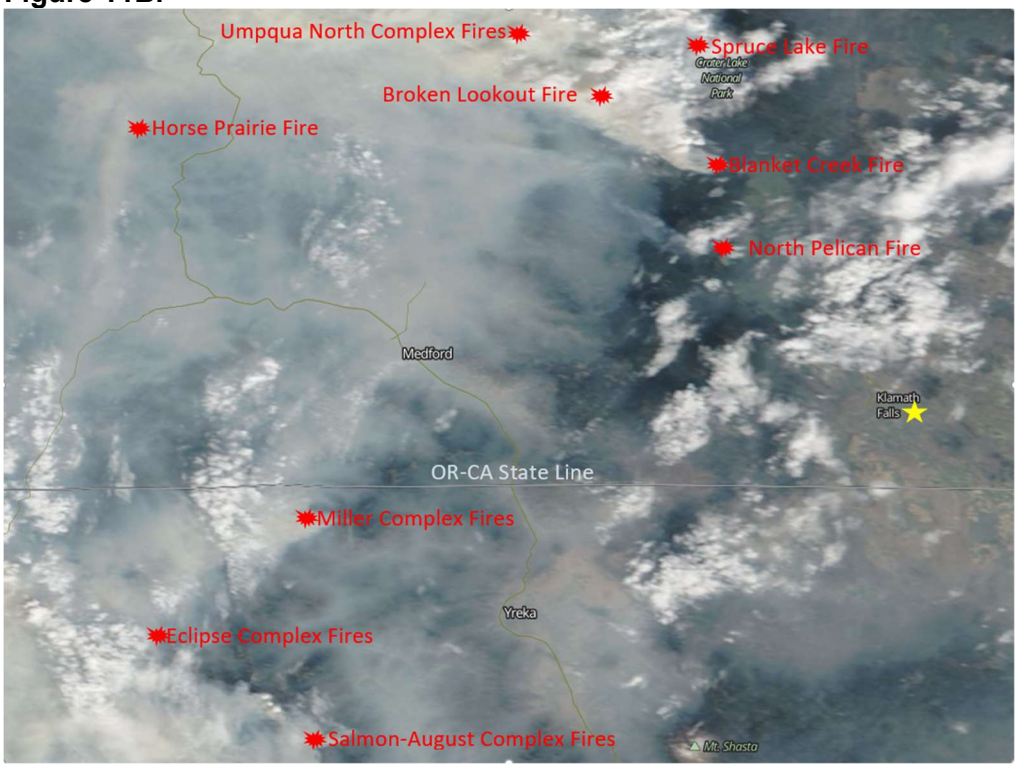


Figure 11C.

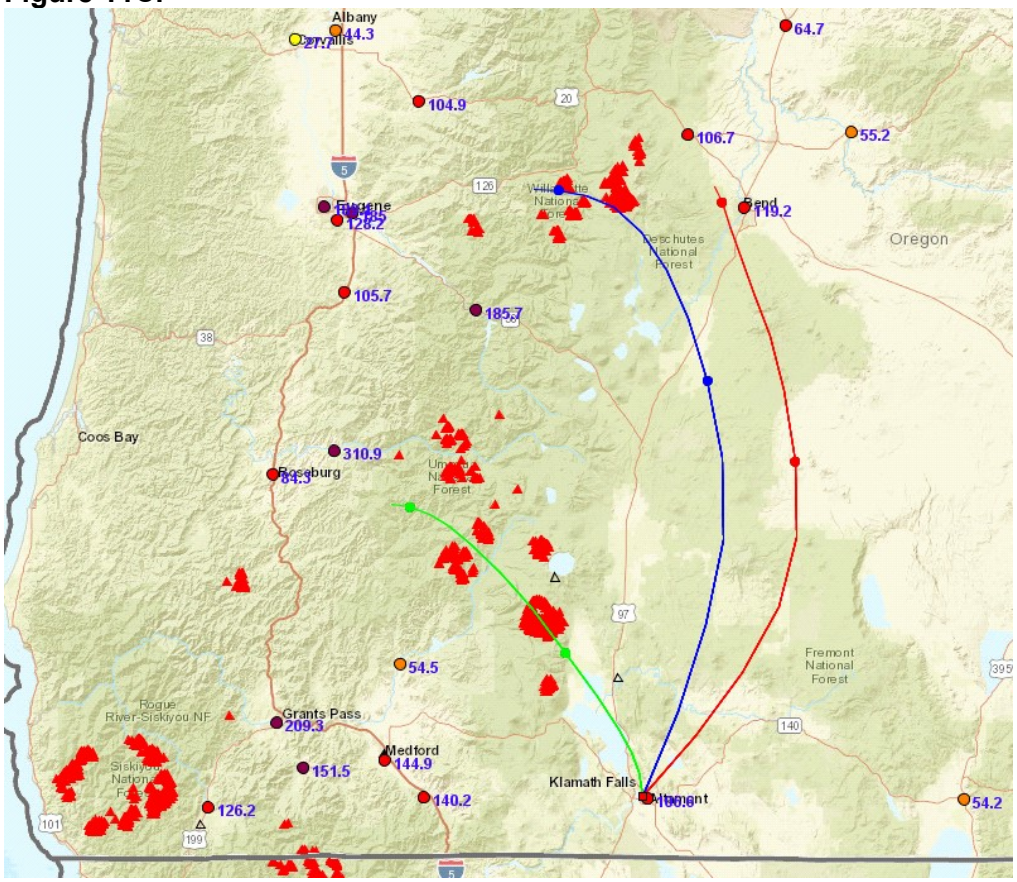
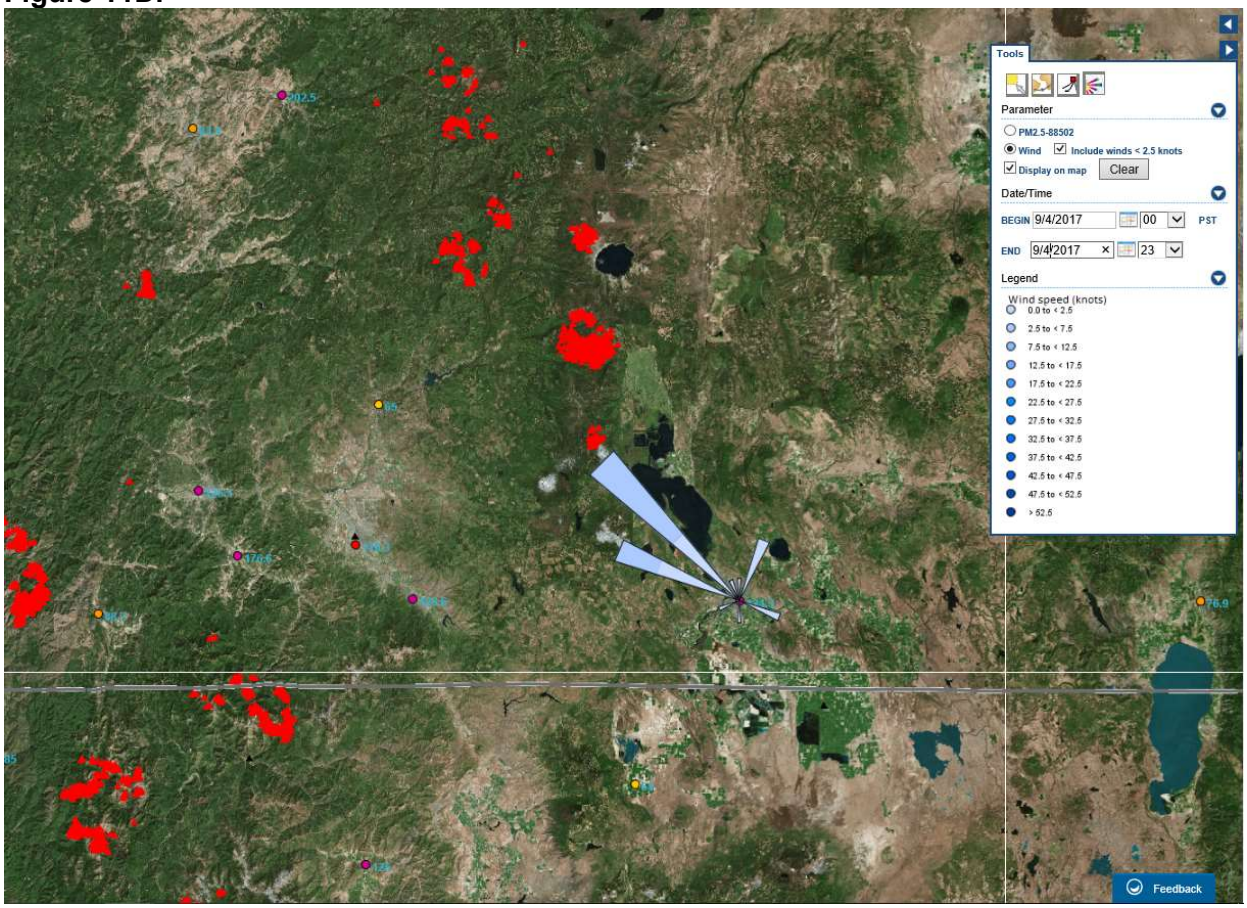


Figure 11D.


Tools
Parameter
PM2.5-88502
Wind
Include winds < 2.5 knots
Display on map
Clear
Date/Time
BEGIN 9/4/2017 00 PST
END 9/4/2017 23
Legend
Wind speed (knots)
0.0 to < 2.5
2.5 to < 7.5
7.5 to < 12.5
12.5 to < 17.5
17.5 to < 22.5
22.5 to < 27.5
27.5 to < 32.5
32.5 to < 37.5
37.5 to < 42.5
42.5 to < 47.5
47.5 to < 52.5
> 52.5
Feedback

1.3.5. Oakridge Monitor Impacted Days

8/20/2017

PM2.5 levels remained fairly low in the early morning (< 20 µg/m3), but increased dramatically once the wind direction shifted mid-morning, bringing smoke from southern fires (Staley, Fall Creek, Happy Dog, Broken Lookout, Spruce Lake and Blanket Creek) (Figure 12A, 12B, and 12 D). Peak PM2.5 levels were > 250 µg/m3. As the HYSPLIT model run shows, some smoke may have come from the California wildfires (Eclipse Complex and Salmon-August Complex) (Figure 12C).The large jump in PM2.5 levels also corresponded to an increase in wind speed.

Figure 12A-D. Time series, satellite smoke image, modeling results for Oakridge monitor, and frequency wind speed using wind direction at Oakridge 8/20/17.

Figure 12A.

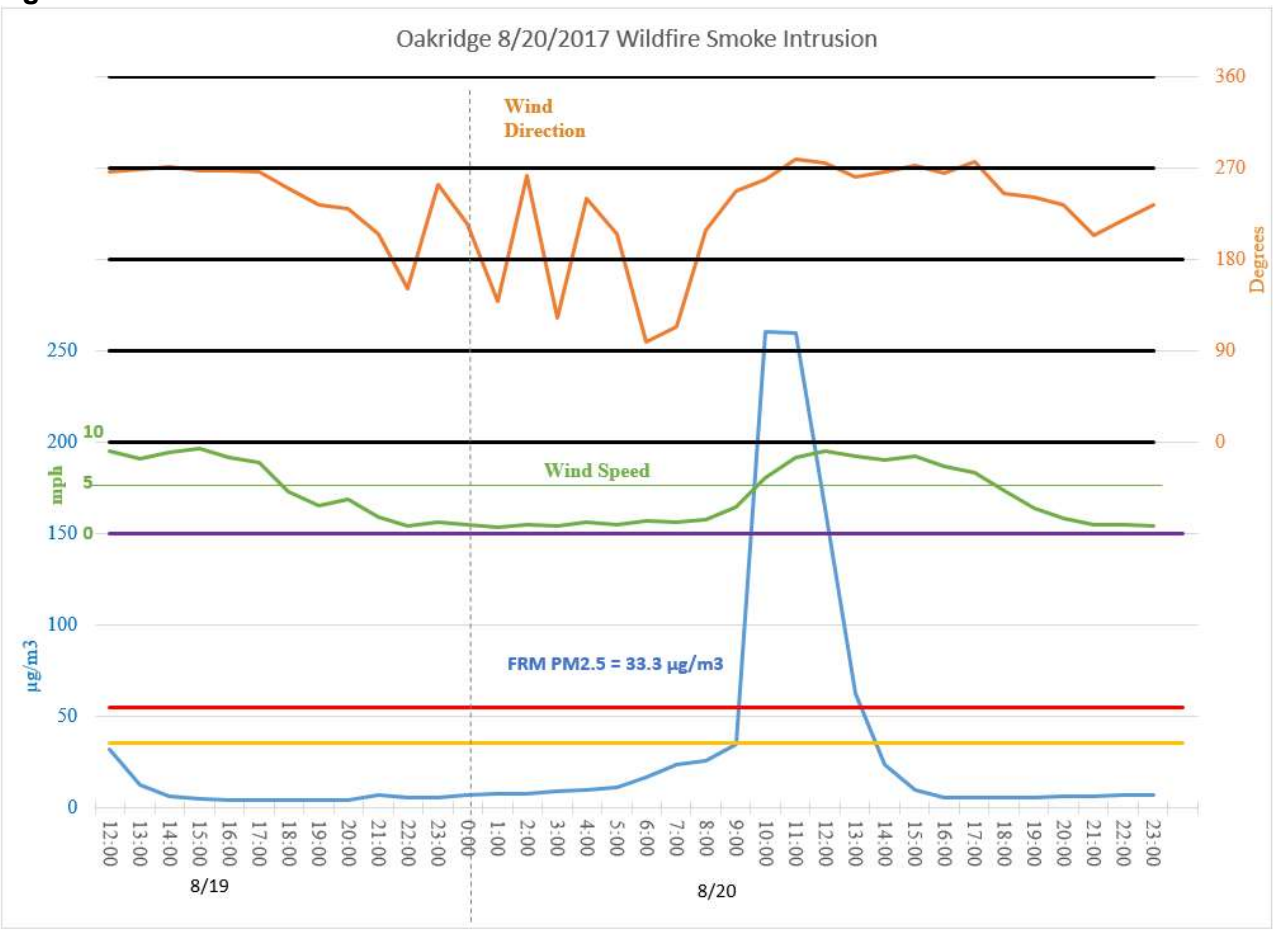


Figure 12B.

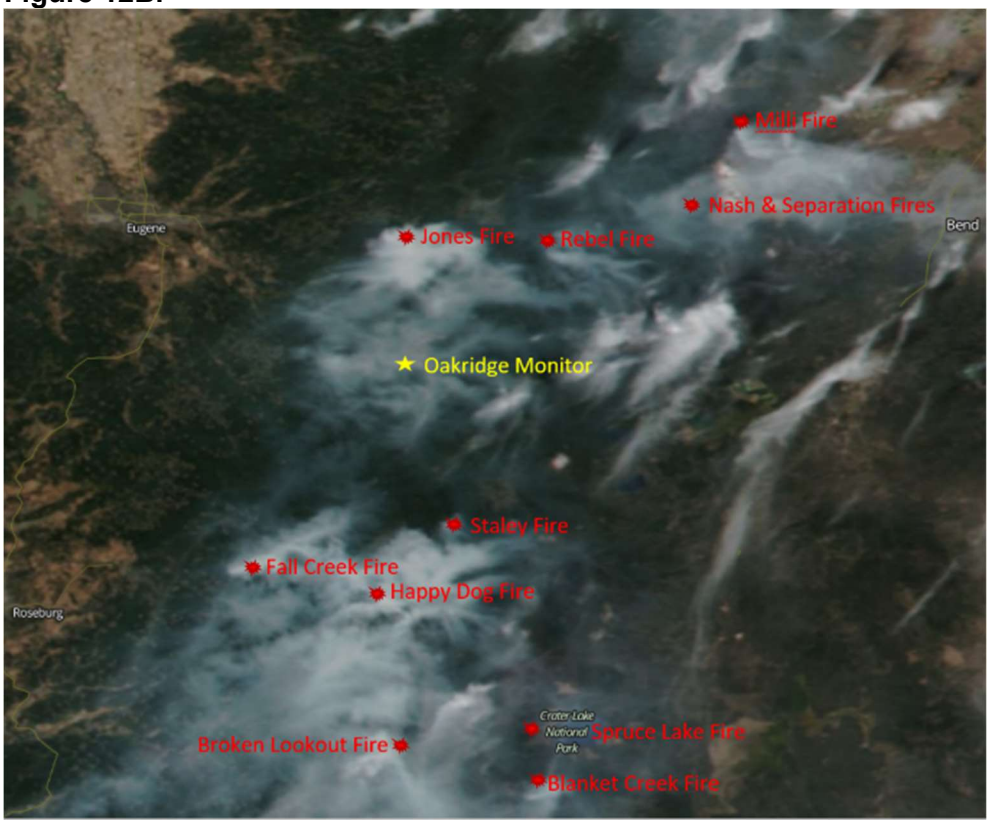


Figure 12C.

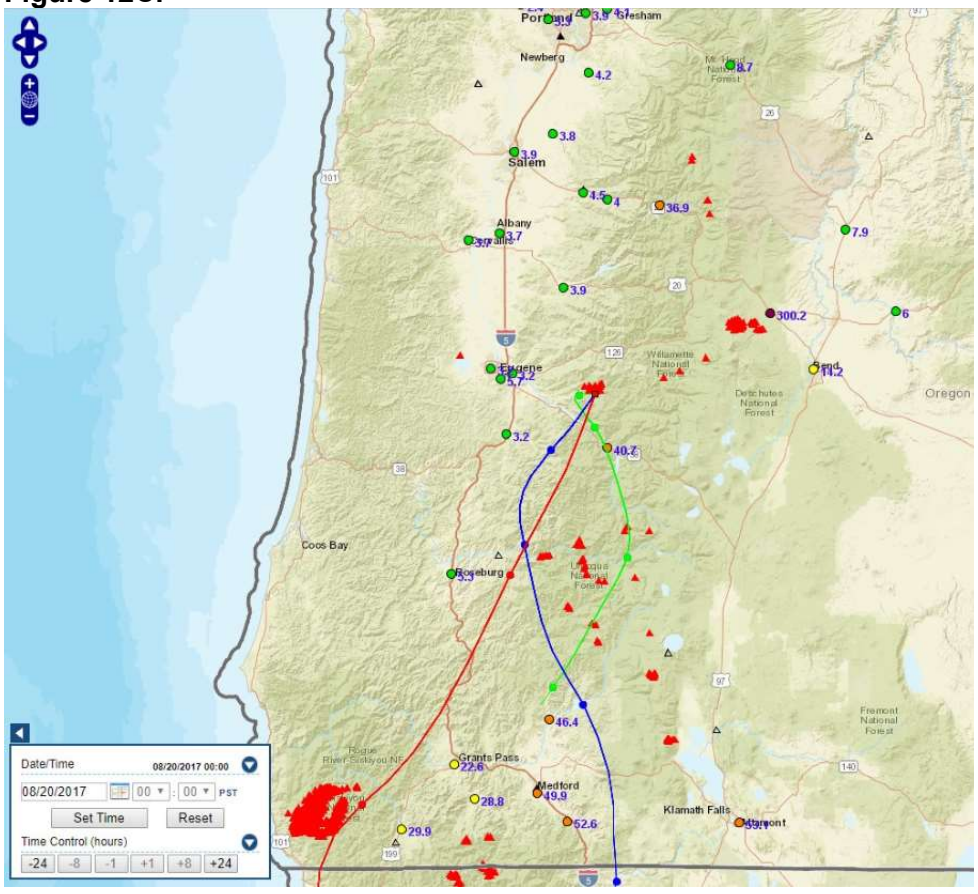
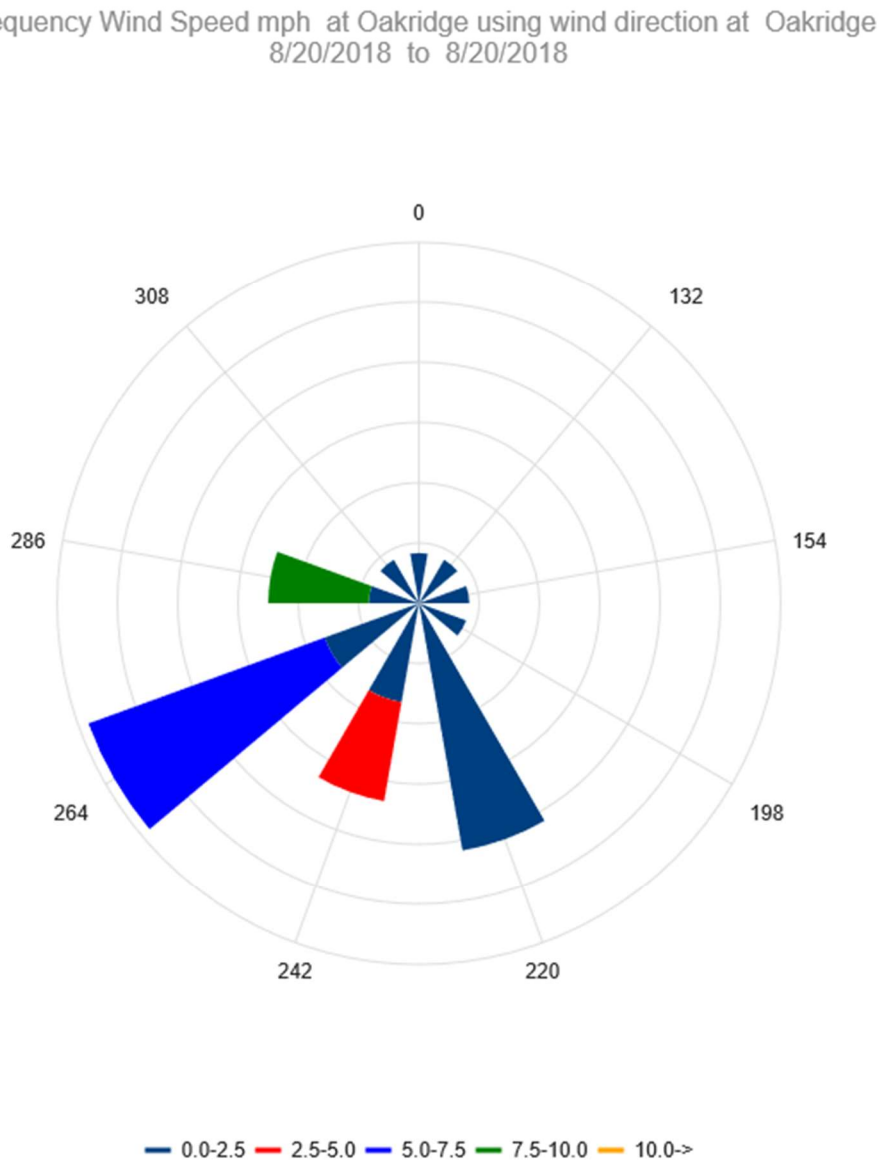


Figure 12D.


Frequency Wind Speed mph at Oakridge using wind direction at Oakridge
8/20/2018 to 8/20/2018
0
132
154
198
220
242
264
286
308
0.0-2.5
2.5-5.0
5.0-7.5
7.5-10.0
10.0->
Calm: 0.00%

8/26/2017

PM2.5 began to increase around 6 a.m., when the wind was coming from a WSW direction. Peak PM2.5 (89.5 µg/m3) occurred around mid-afternoon, when the wind was from a W direction (Figure 13A). The large increase in PM2.5 also corresponded to an increase in wind speed. The likely sources of smoke were from southern fires (Staley, Umpqua North Complex, Broken Lookout, Chetco Bar, and Miller Complex) (Figure 13B). As the HYSPLIT model run shows, some smoke may have come from the California wildfires (Eclipse Complex and Salmon-August Complex) (Figure 13CD).

Figure 13A-D. Time series, satellite smoke image, and modeling results for Oakridge monitor, 8/26/17.

Figure 13A.

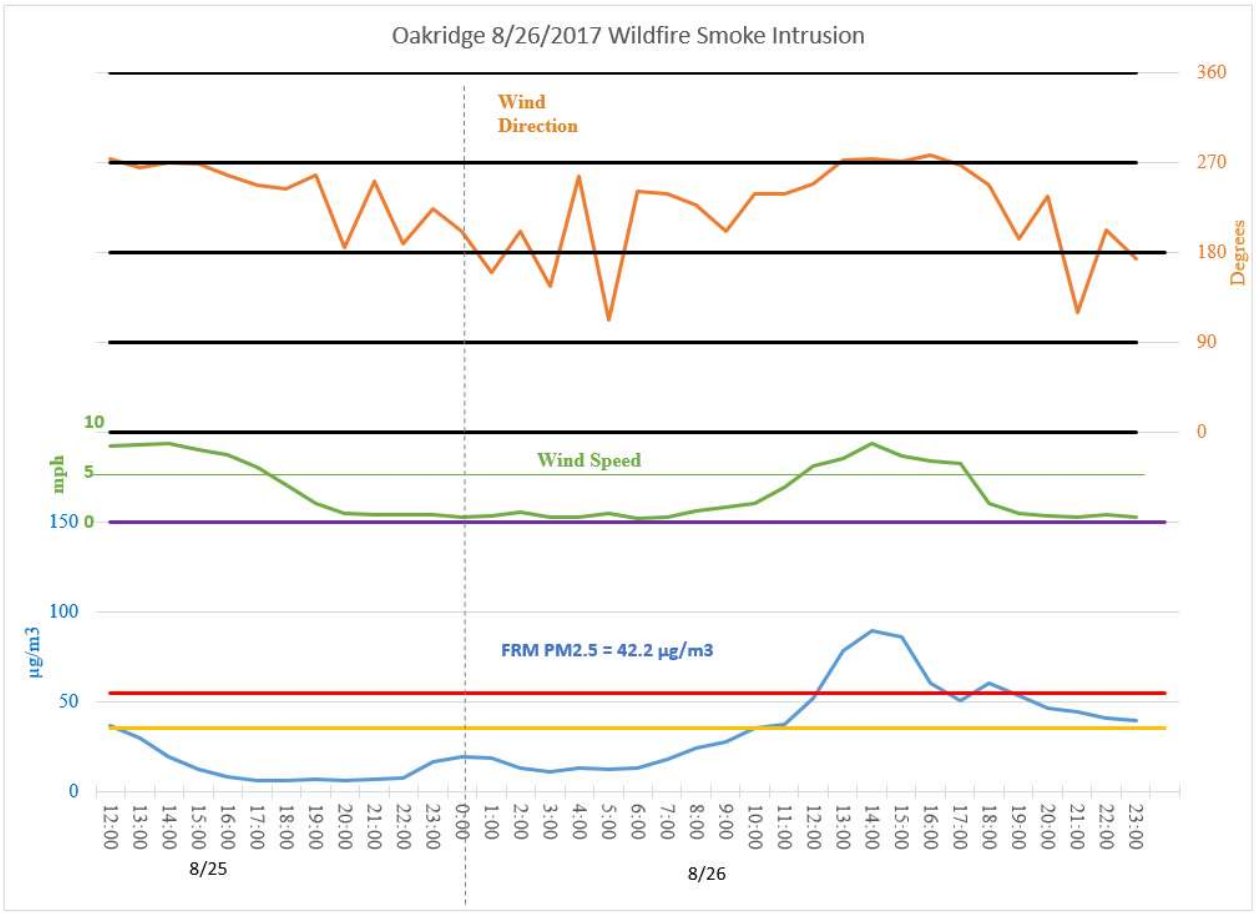


Figure 13B.

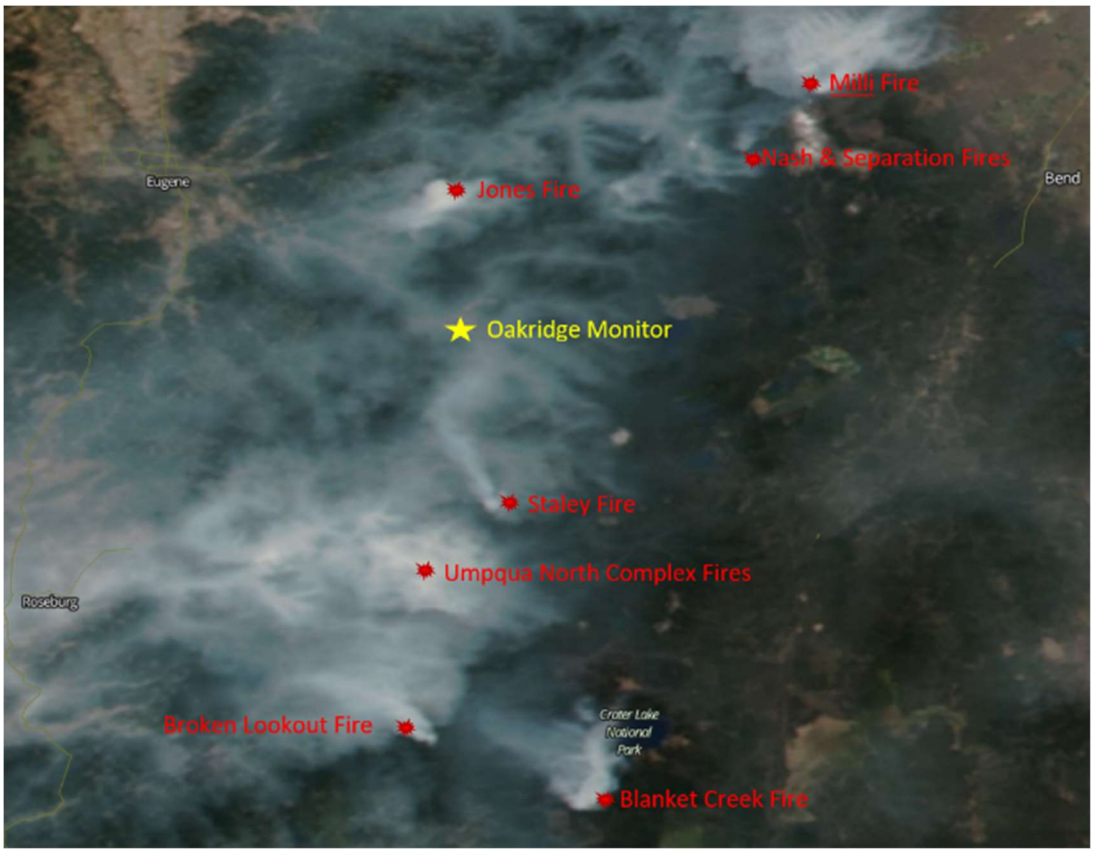


Figure 13C.

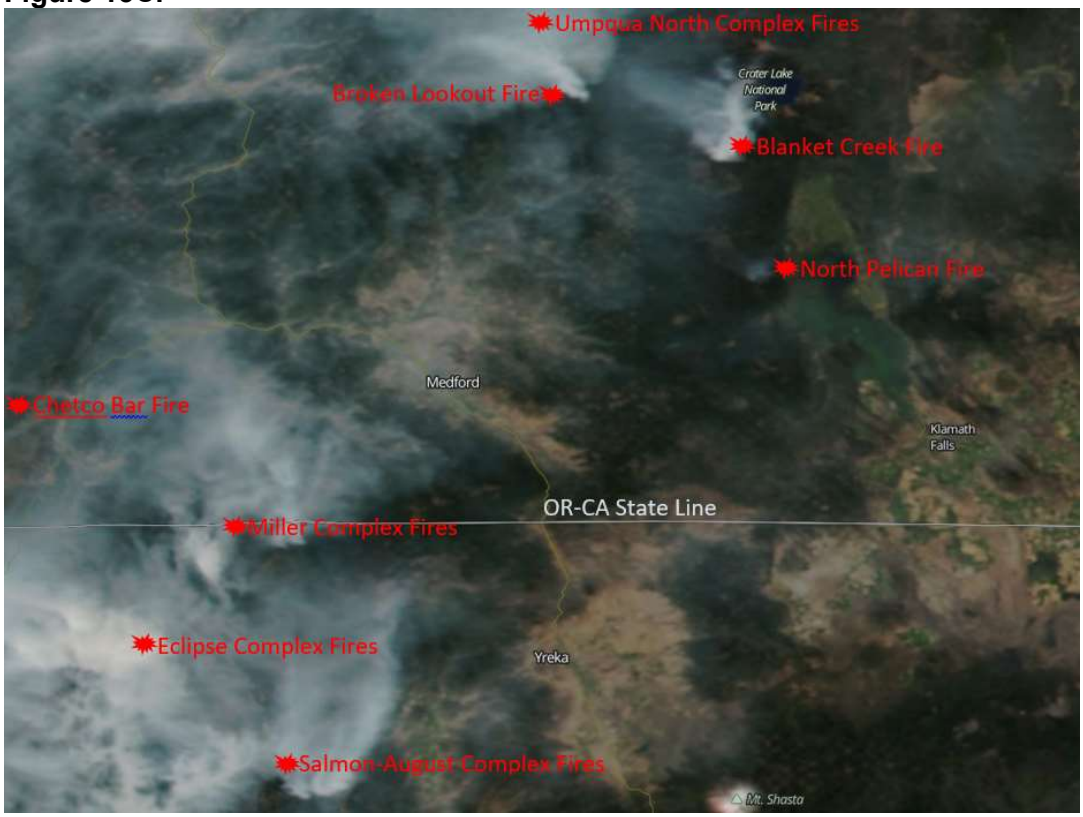
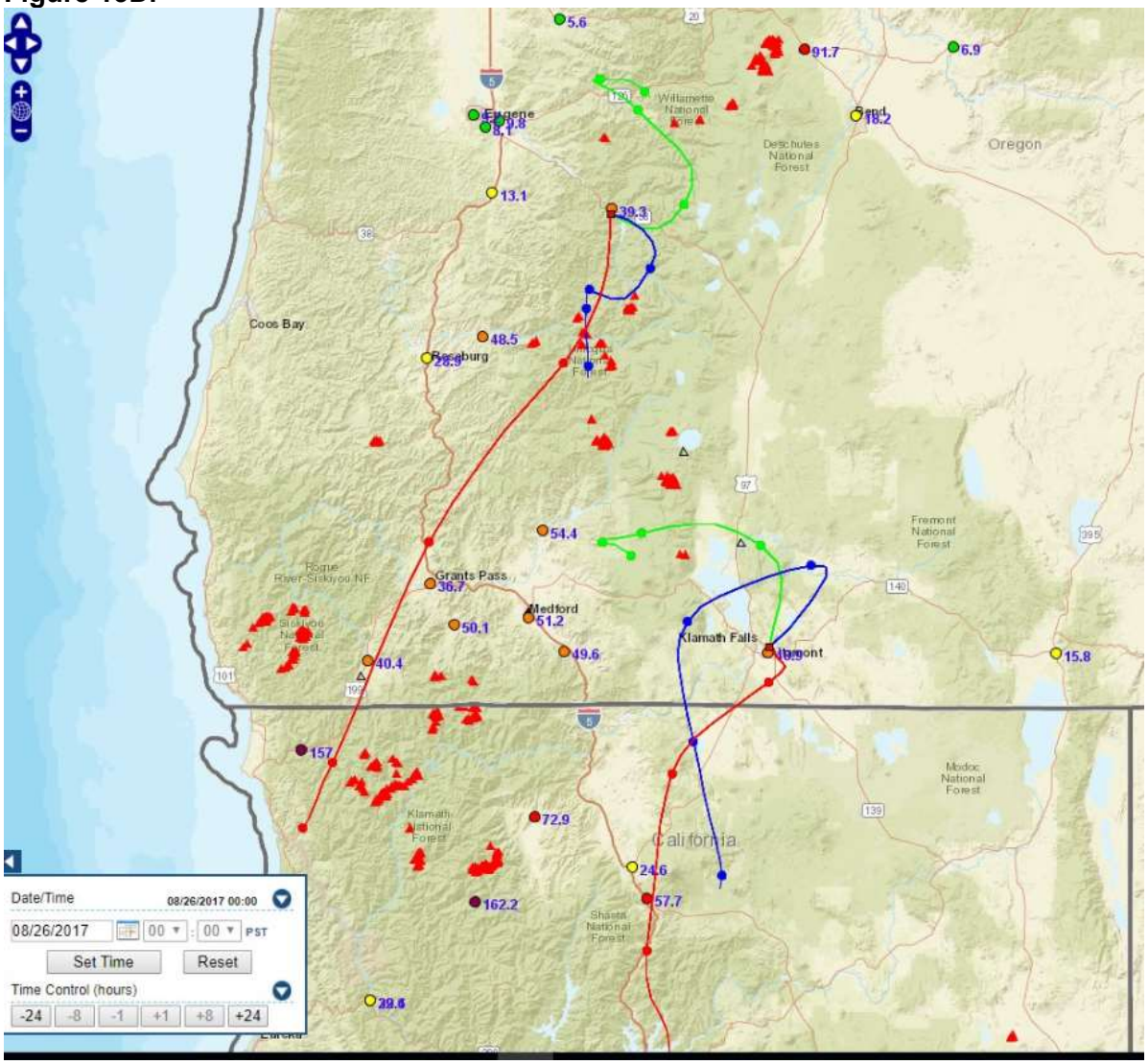


Figure 13D.


5.6
91.7
6.9
Eugene
9.8
18.2
Oregon
Deschutes National Forest
13.1
39.3
Coos Bay
48.5
28.9
Roseburg
54.4
Fremont National Forest
Rogue River-Siskiyou NF
Grants Pass
36.7
Medford
51.2
50.1
Klamath Falls
49.6
40.4
15.8
157
Modoc National Forest
Klamath National Forest
72.9
California
24.6
162.2
57.7
Shasta National Forest
Date/Time
08/26/2017 00:00
08/26/2017
00
00
PST
Set Time
Reset
Time Control (hours)
-24
-8
-1
+1
+8
+24

8/29/2017

Large smoke plumes were coming from multiple fires to the N, S, E, and W of the Oakridge monitor (Figure 14B and 14D). A thermal trough unexpectedly accelerated existing fires and strong W winds caused PM2.5 to reach unhealthy levels. The highest PM2.5 level (127.6 µg/m3) occurred midday, when wind speed was elevated and the wind direction was WSW to W (Figure 14AC). The largest increase in PM2.5 was likely from the Fall Creek, Staley and Umpqua North Complex Fires.

Figure 14A-D. Time series, satellite smoke image, and modeling results for Oakridge monitor, 8/29/17.

Figure 14A.

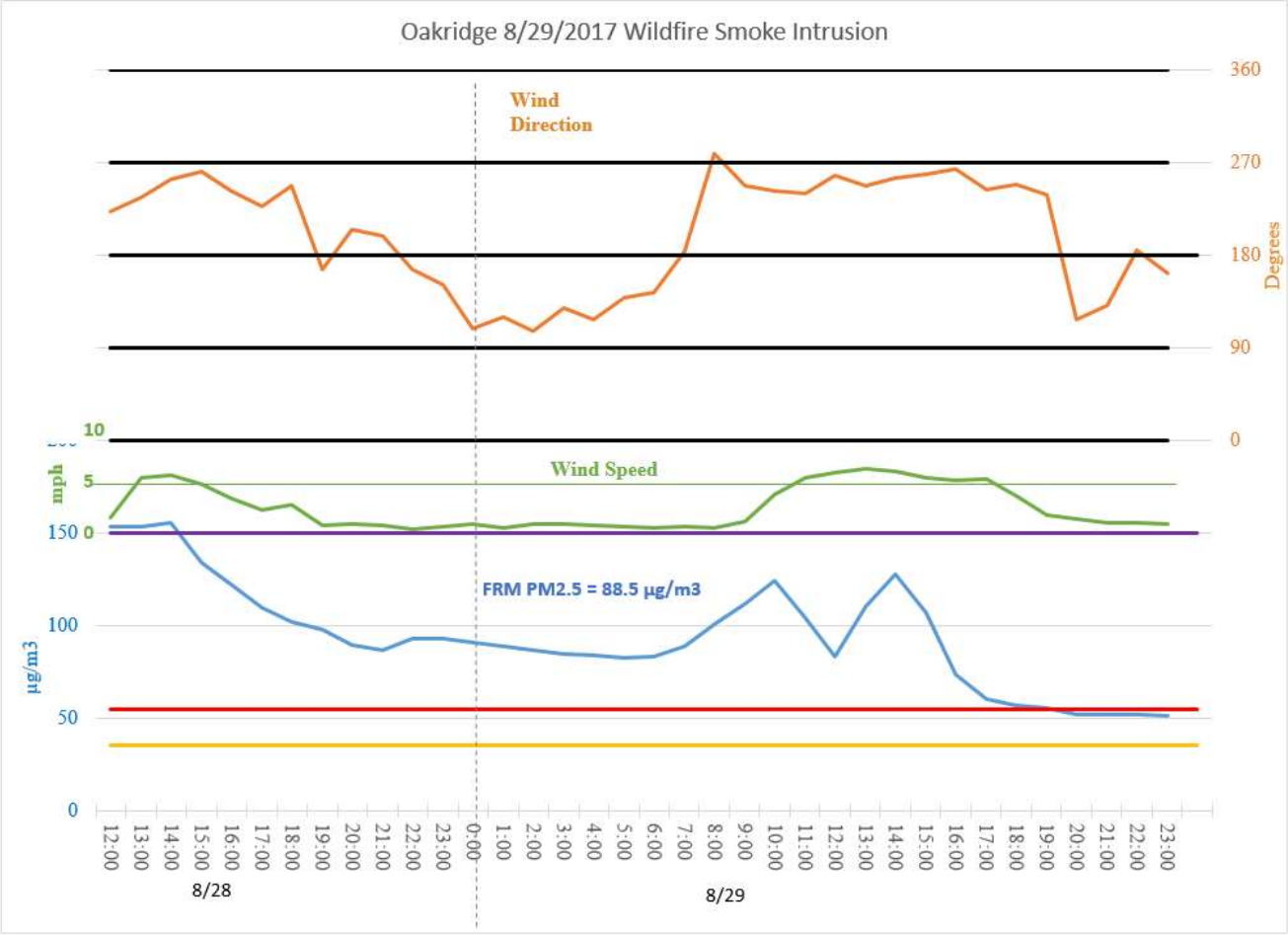


Figure 14B.

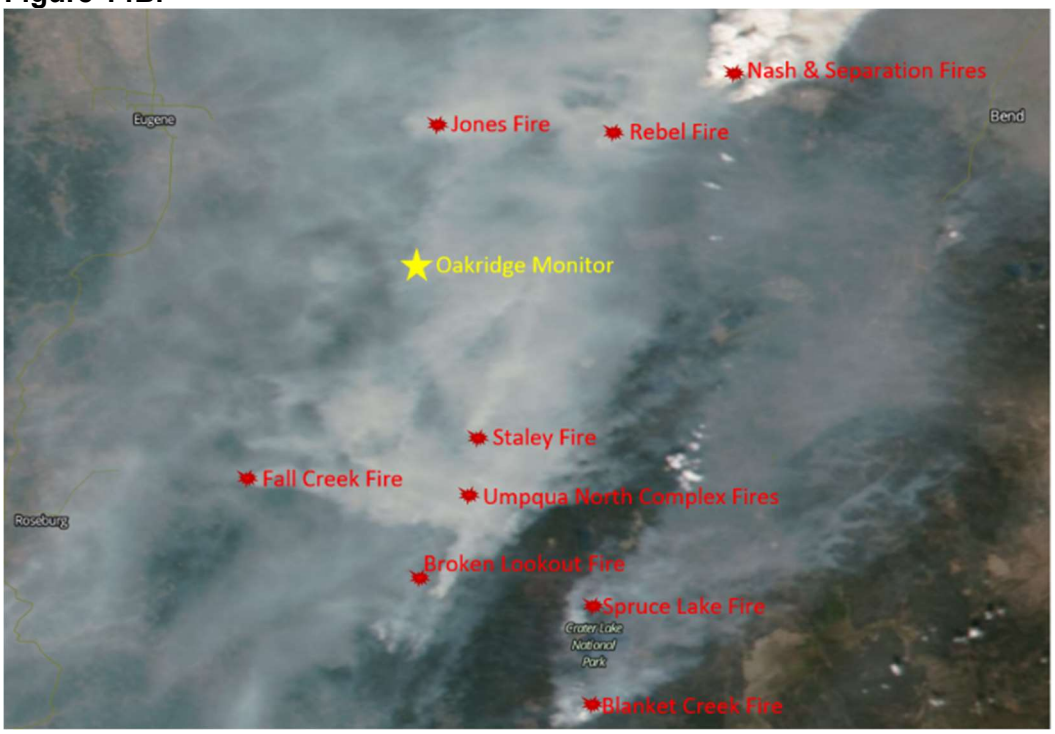


Figure 14C.

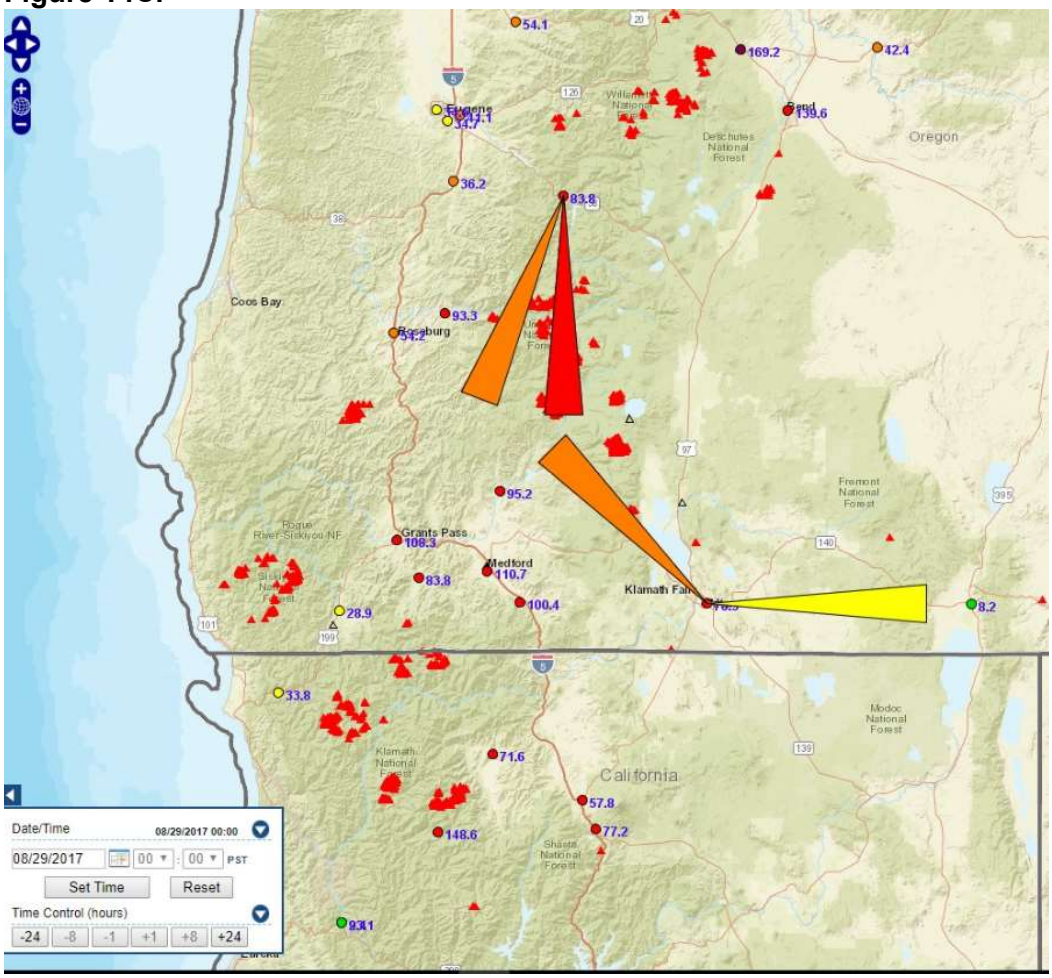
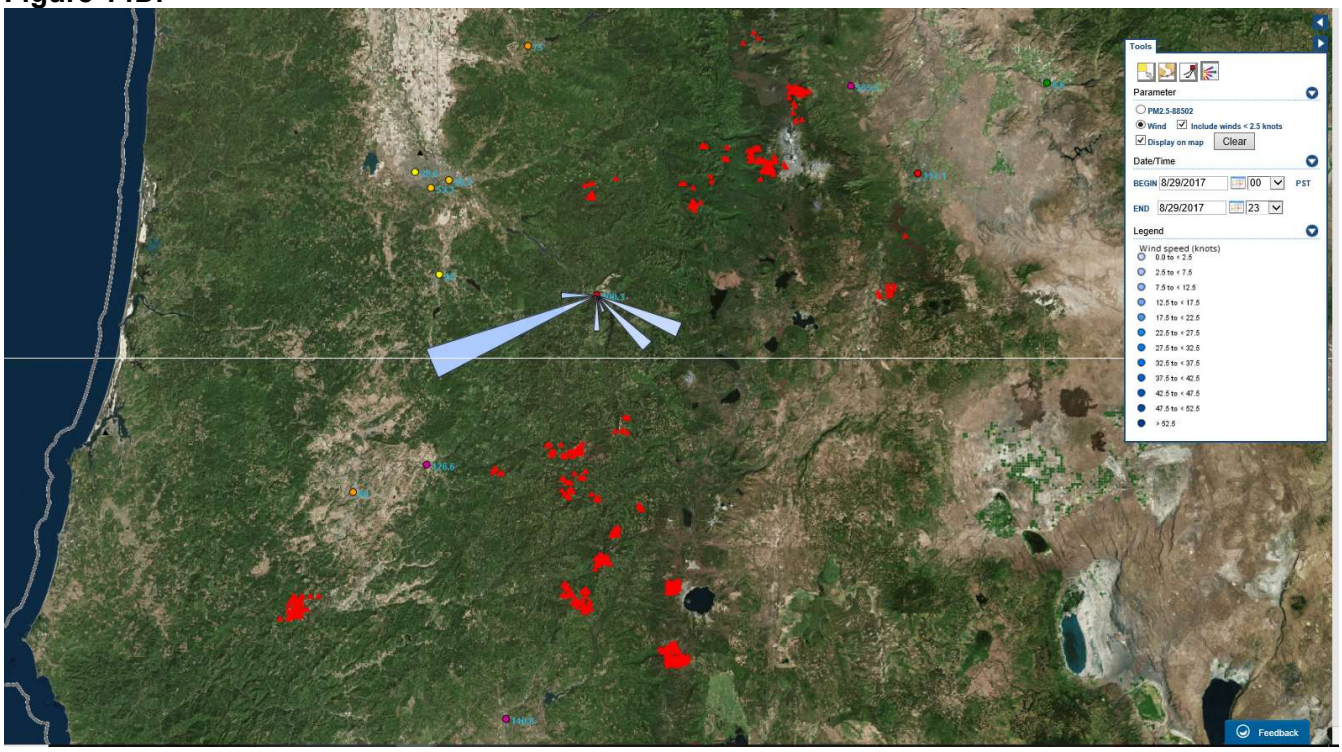


Figure 14D.


Tools
Parameter
PM2.5-88502
Wind
Include winds < 2.5 knots
Display on map
Clear
Date/Time
BEGIN 8/29/2017 00 PST
END 8/29/2017 23
Legend
Wind speed (knots)
0.0 to < 2.5
2.5 to < 7.5
7.5 to < 12.5
12.5 to < 17.5
17.5 to < 22.5
22.5 to < 27.5
27.5 to < 32.5
32.5 to < 37.5
37.5 to < 42.5
42.5 to < 47.5
47.5 to < 52.5
> 52.5
Feedback

9/1/2017

PM2.5 levels were low in the early morning, but increased sharply around 6 a.m. when the wind switched to a S and SW direction (Figure 15A). PM2.5 levels peaked at 209.9 µg/m3 at 4 p.m. when the wind speed was greatest. The most likely fires contributing to the smoke were: Staley, Umpqua North Complex, Spruce Lake, Blanket Creek and Broken Lookout.

Figure 15A-E. Time series, satellite smoke image, and modeling results for Oakridge monitor, 9/1/17.

Figure 15A.

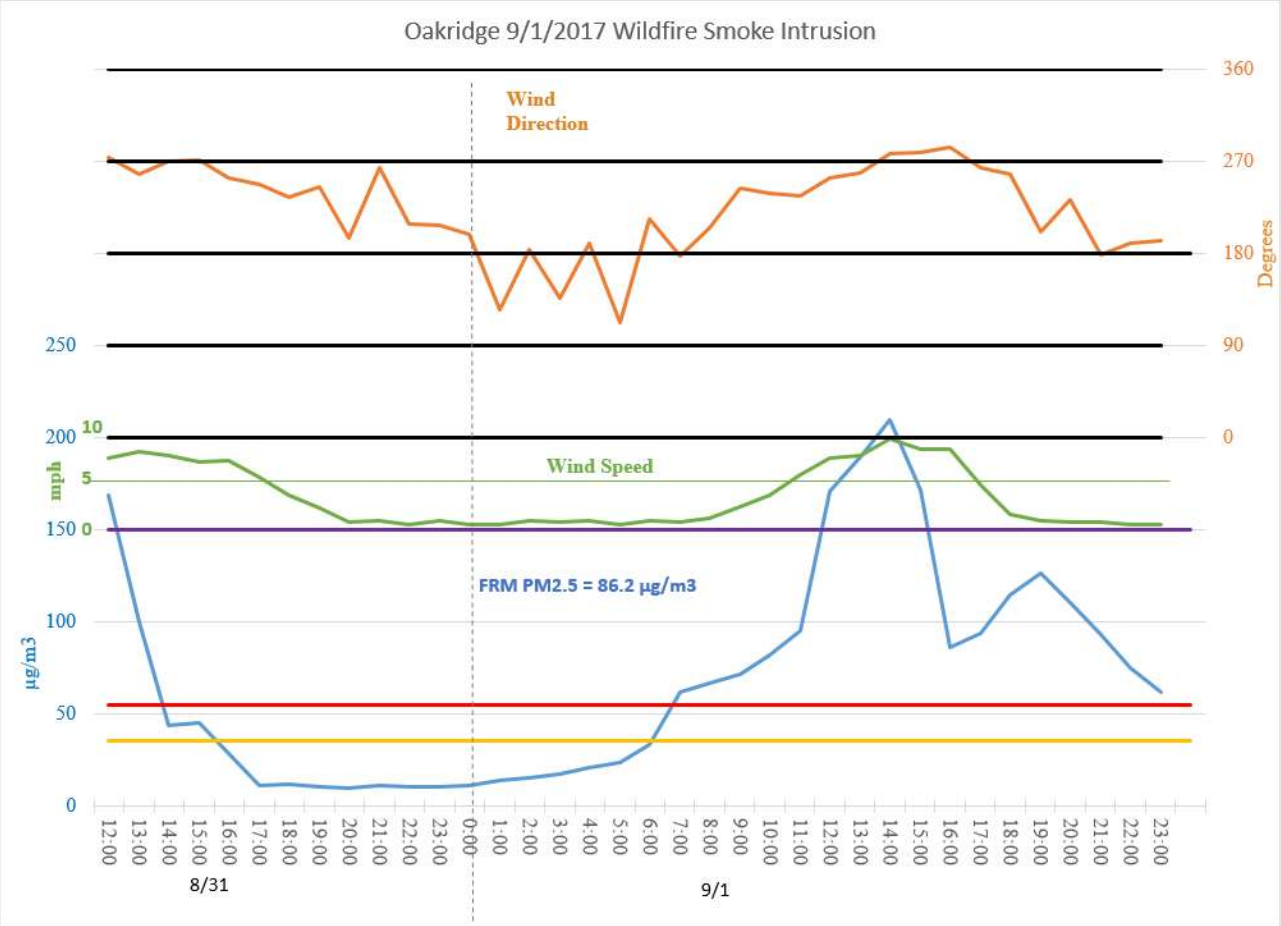


Figure 15B.

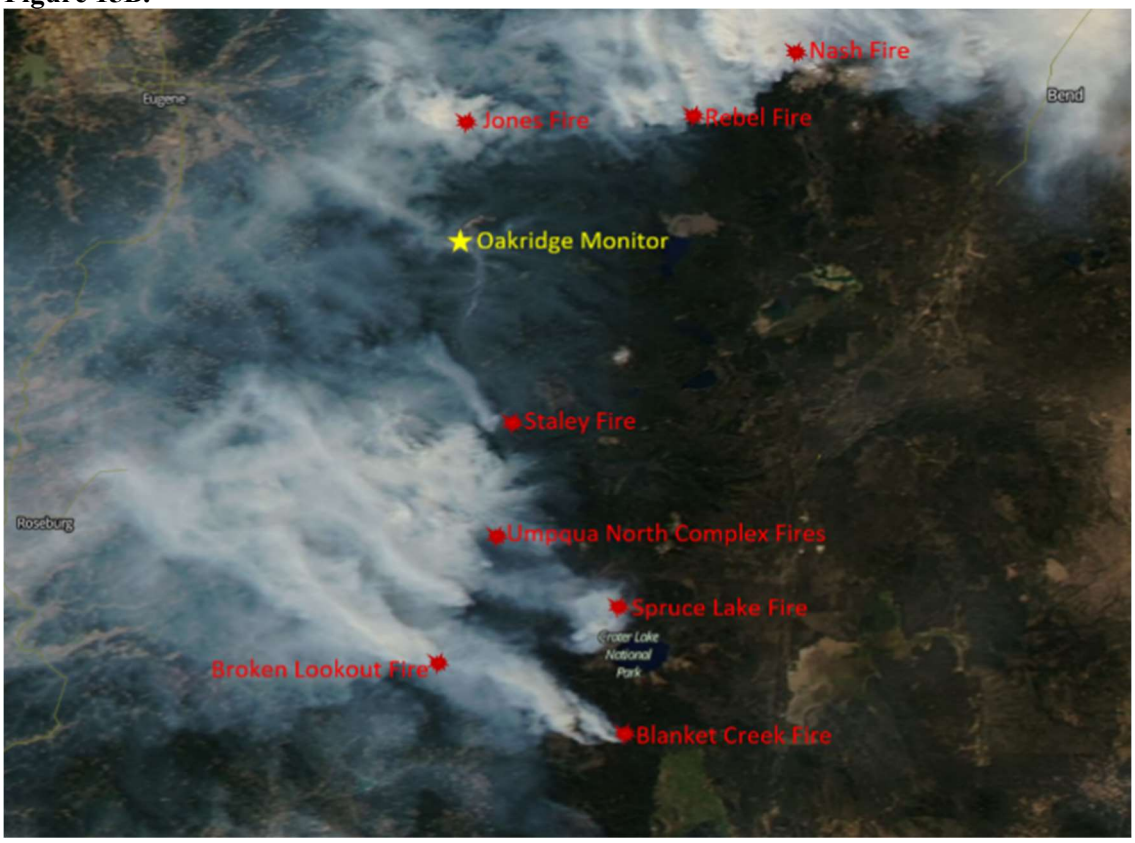


Figure 15C.

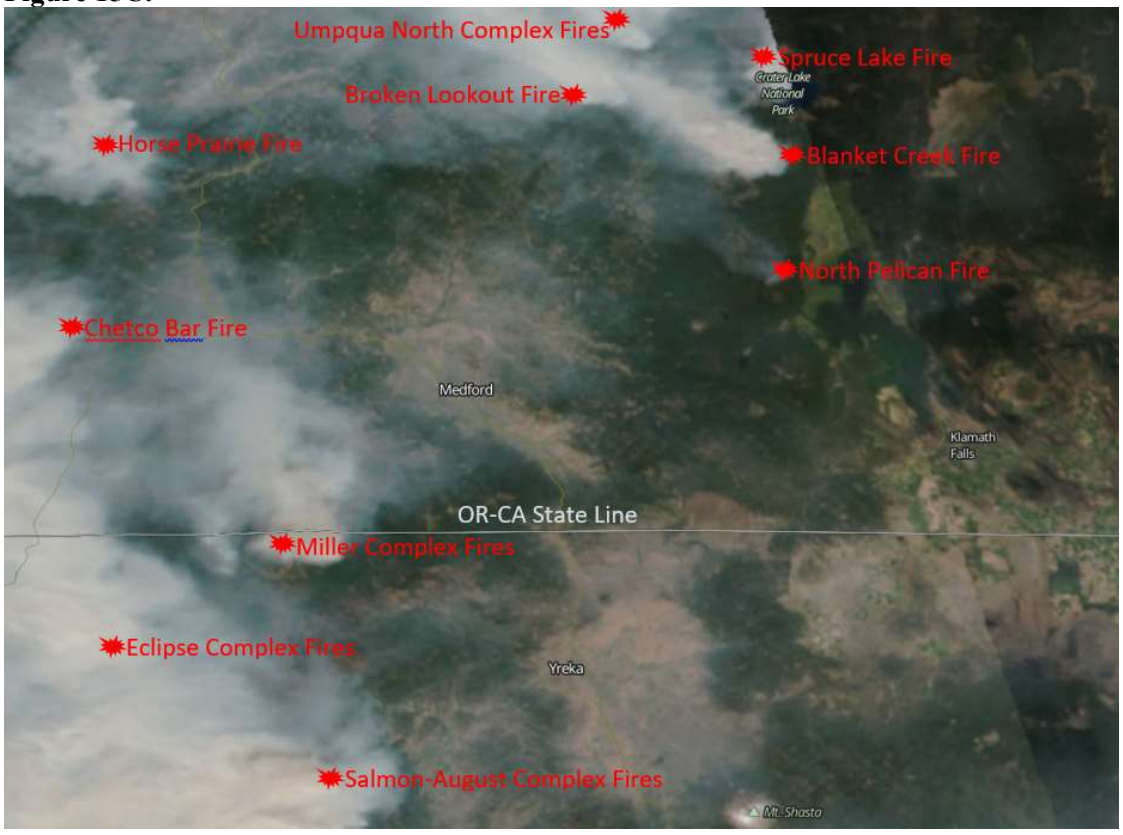


Figure 15D.

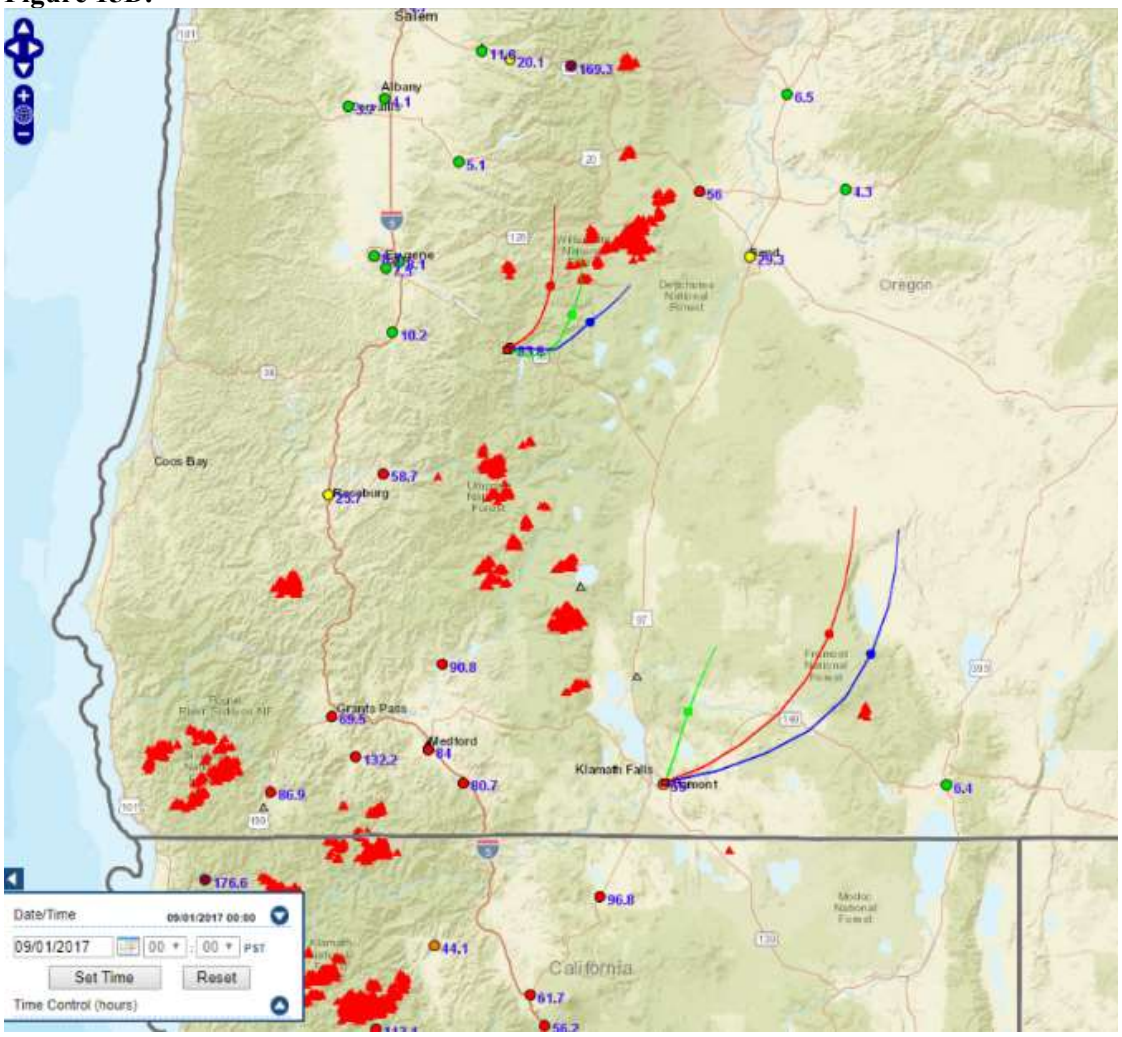
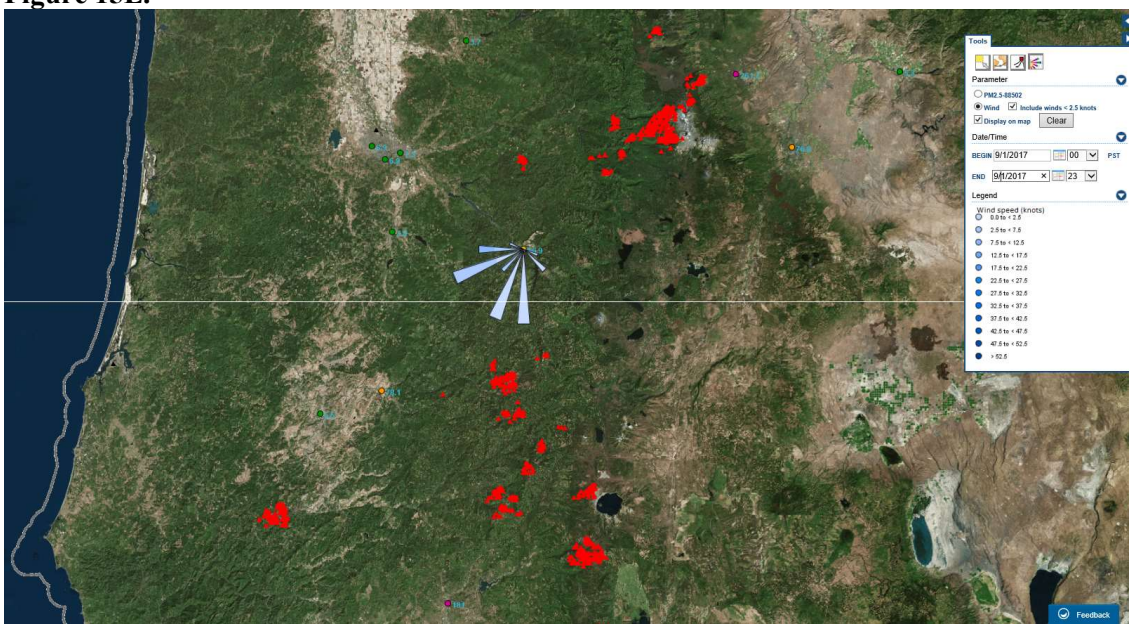


Figure 15E.



9/4/2017

PM2.5 was exceedingly high throughout the entire day. However, a large spike in PM2.5 occurred midday, following an increase in wind speed and a wind direction of S to SW. Peak PM2.5 (382.5 µg/m3) occurred at 3 p.m. (Figure 16ABC). The most likely fires contributing to the smoke were: Staley, Umpqua North Complex, Spruce Lake, Blanket Creek and Broken Lookout (Figure 16BD).

Figure 16A-D. Time series, satellite smoke image, and modeling results for Oakridge monitor, 9/4/17.

Figure 16A.

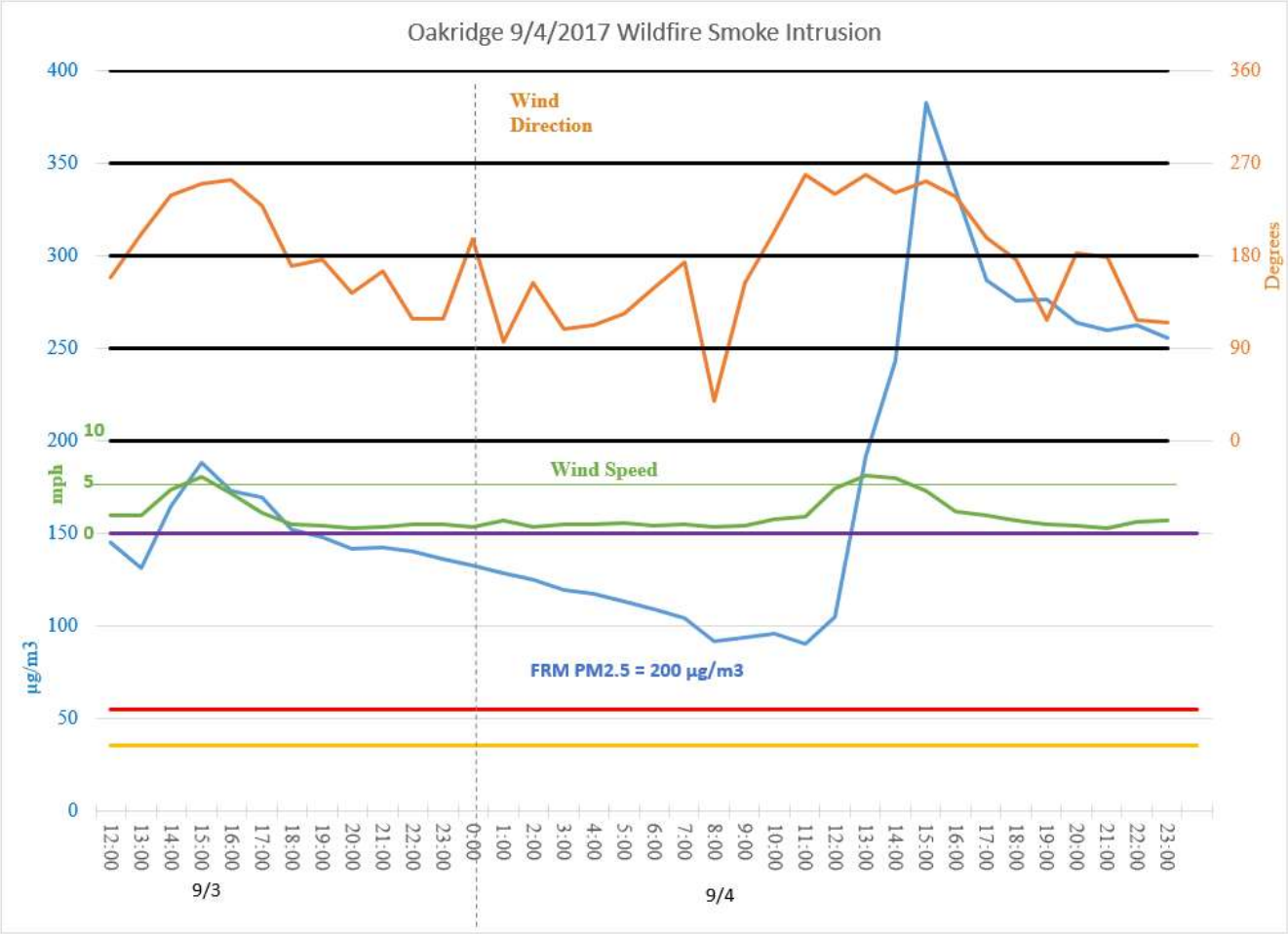


Figure 16B.

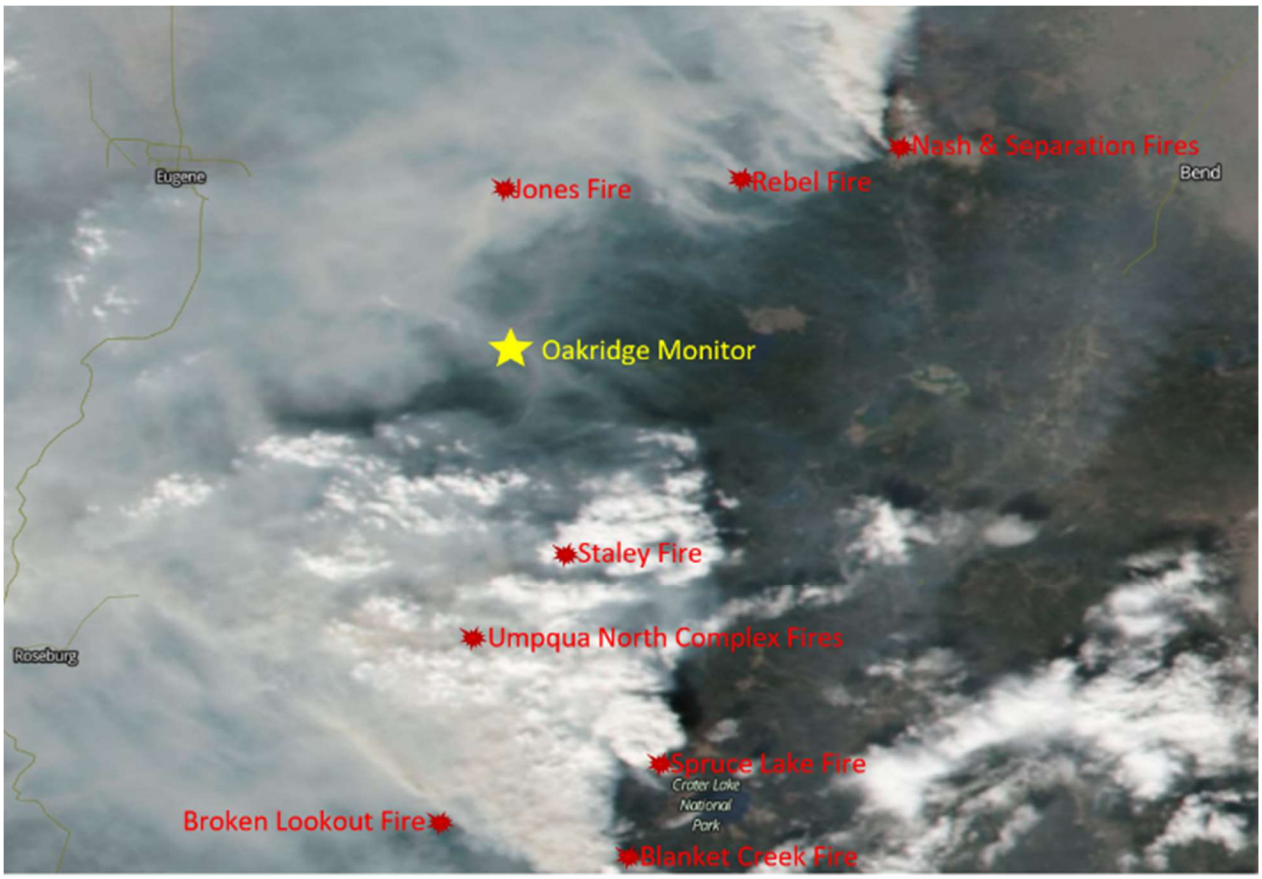
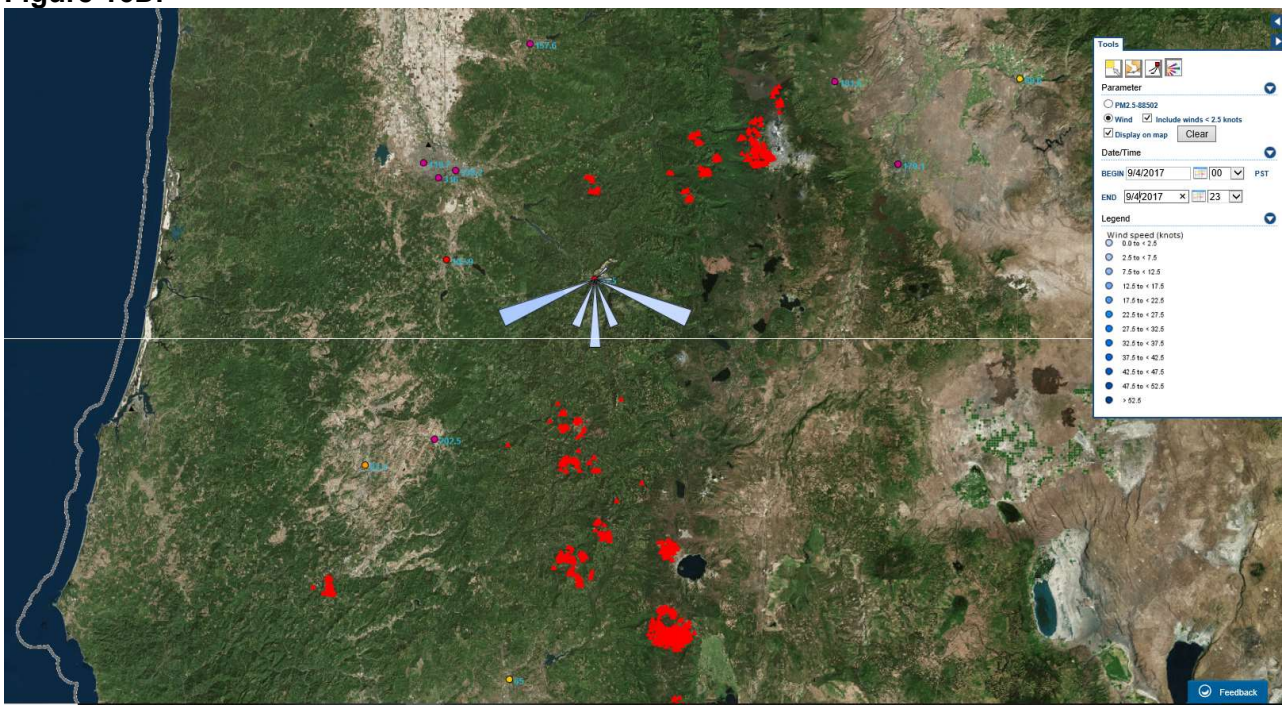


Figure 16C.

Figure 16D.


Tools
Parameter
PM2.5-88502
Wind
Include winds < 2.5 knots
Display on map
Clear
Date/Time
BEGIN 9/4/2017 00 PST
END 9/4/2017 23
Legend
Wind speed (knots)
0.0 to < 2.5
2.5 to < 7.5
7.5 to < 12.5
12.5 to < 17.5
17.5 to < 22.5
22.5 to < 27.5
27.5 to < 32.5
32.5 to < 37.5
37.5 to < 42.5
42.5 to < 47.5
47.5 to < 52.5
> 52.5
Feedback

9/7/2017

The wind pattern on 9/7/17 was quite variable, with winds shifting from SE to SW to WNW in the early morning. However, the elevated $PM_{2.5}$ was most consistent with wind originating from a S to SW direction. The most likely fires contributing to the smoke were: Staley, Umpqua North Complex, Spruce Lake, Blanket Creek and Broken Lookout (Figure 17ABC). Specifically, Figure 17C shows ambient smoke from regional wildfires as well as smoke from fires to the SW were significant sources of PM2.5 to this monitor.

Figure 17A-C. Time series, satellite smoke image, and HYSPLIT modeling and wind rose results for Oakridge monitor, 9/7/17.

Figure 17A.

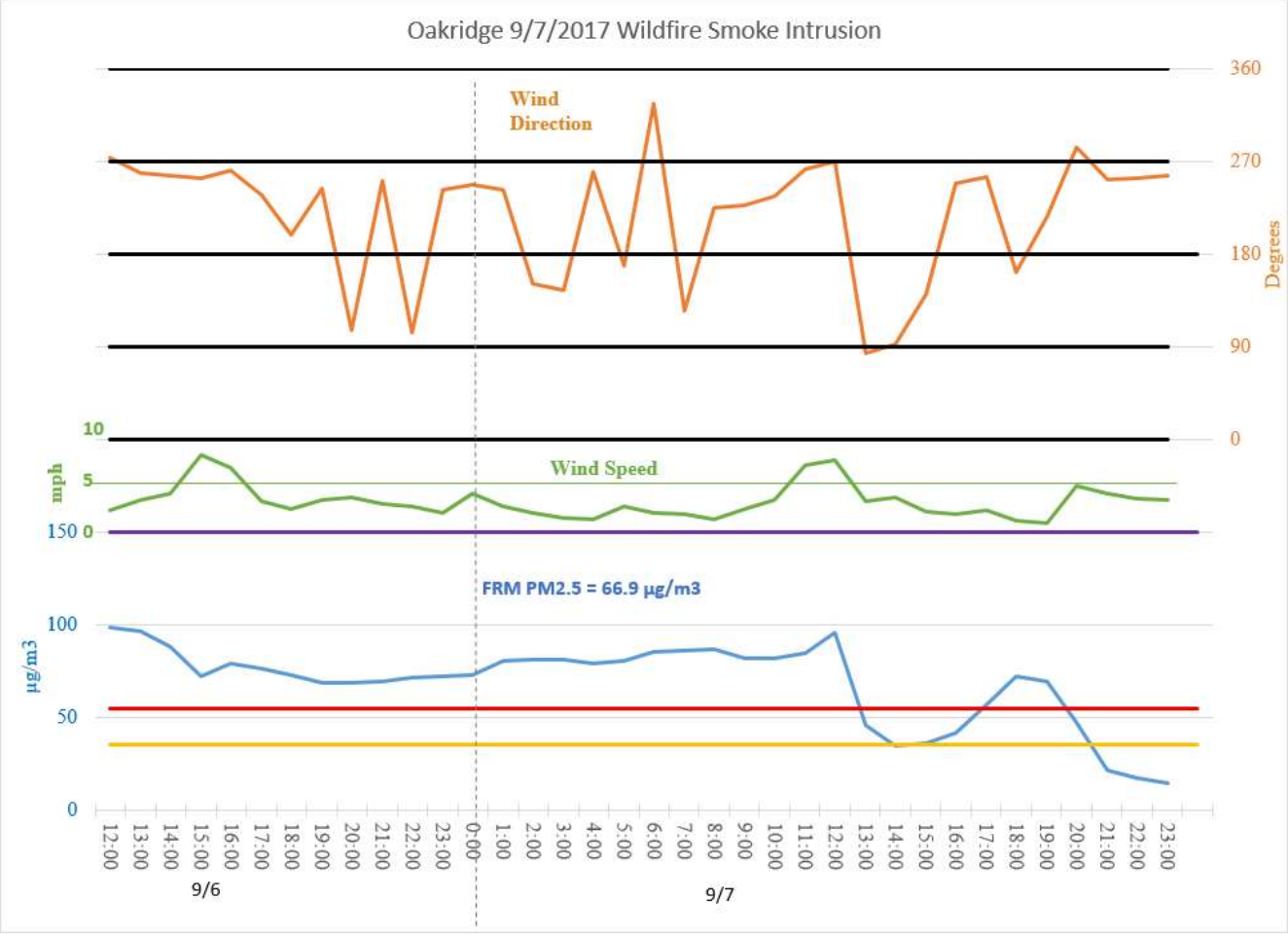


Figure 17B.

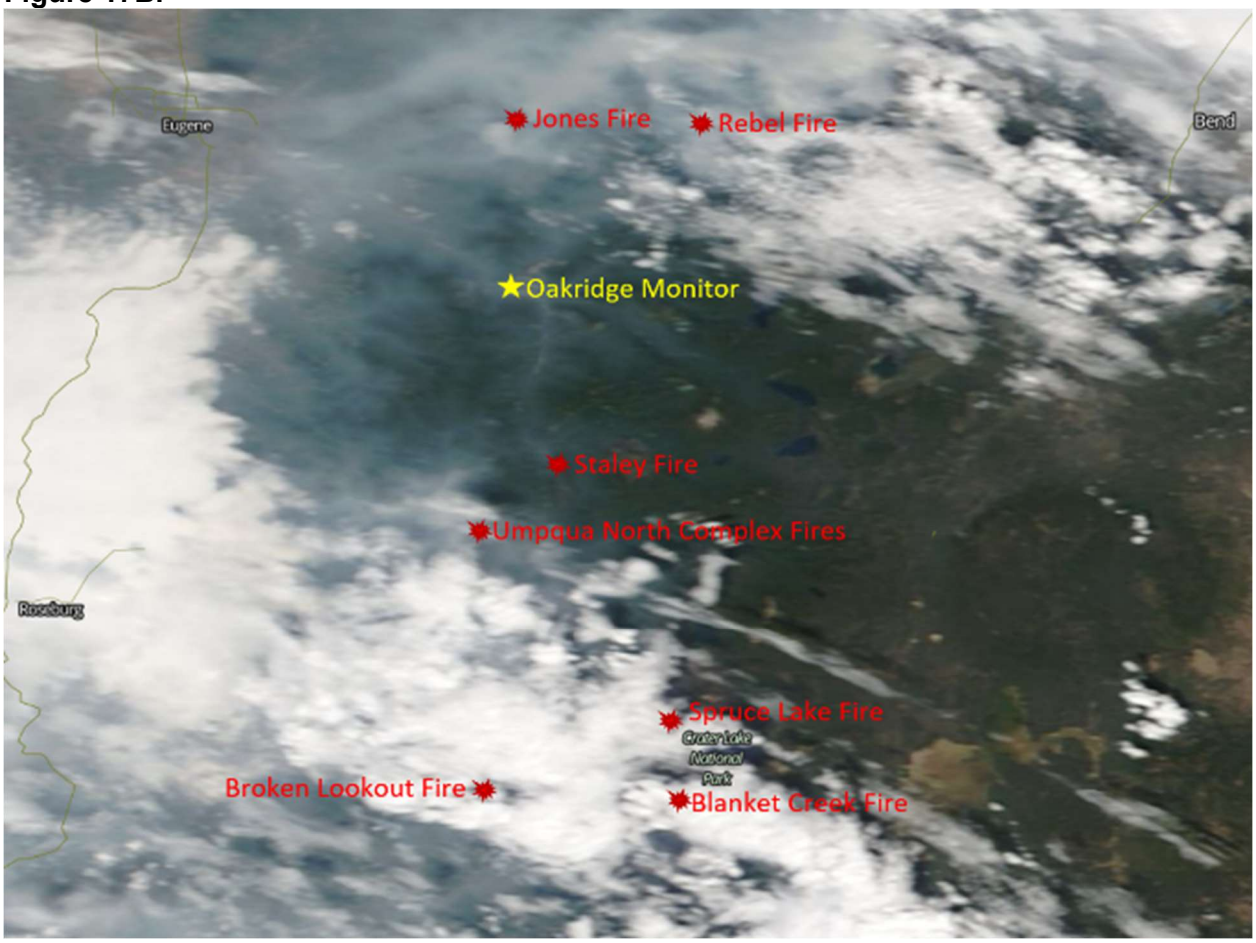
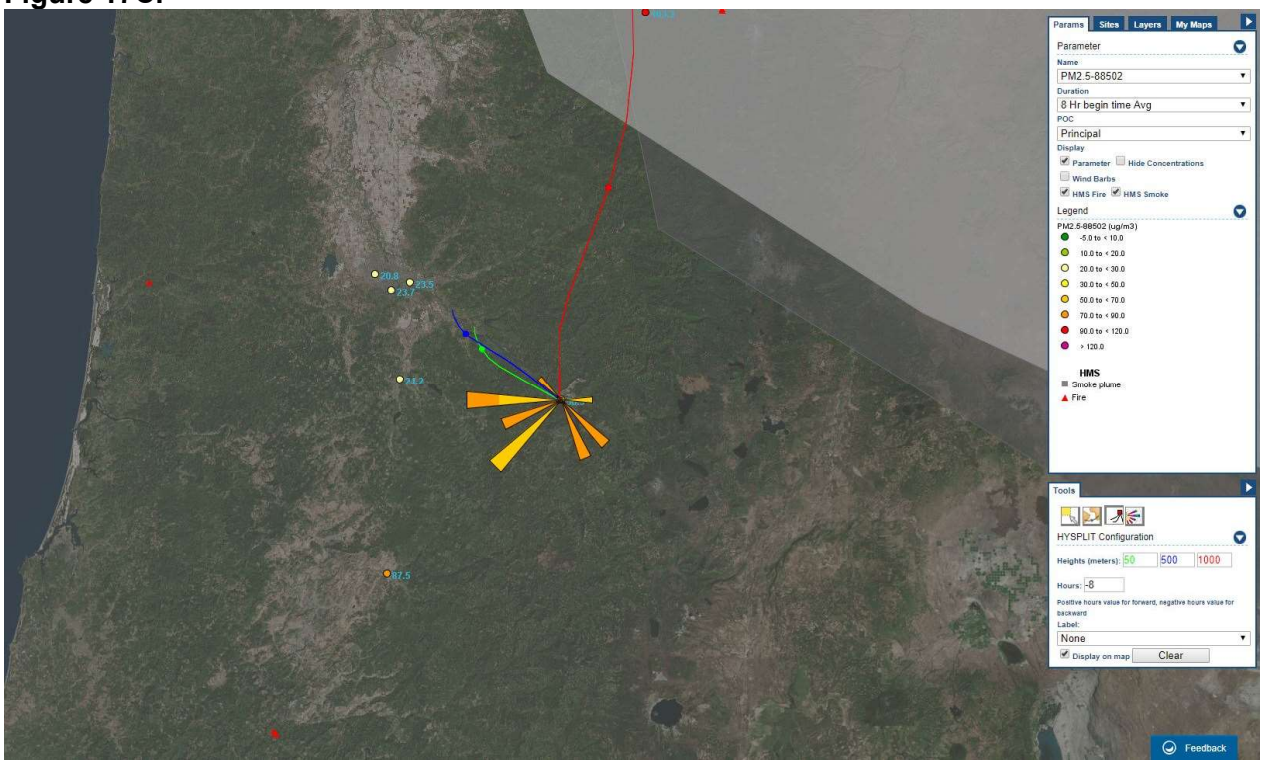


Figure 17C.



9/16/2017

On 9/16/2017 cloud cover over the Oakridge monitor reduced the effectiveness of satellite images. However, Figure 18C shows a satellite image of 9/15/17 with a new wildfire less than ten miles from the Oakridge monitor (Kelsey Creek Fire). In the early morning, and then again in the evening, when the wind was coming from the E, it is likely that this new wildfire increased PM2.5 over Oakridge. However, for much of the day, the elevated PM2.5 occurred when the wind direction was coming from the W. The most likely fires contributing to the smoke were: Staley, Umpqua North Complex, Spruce Lake, Blanket Creek and Broken Lookout (Figure 18ABCDE).

Figure 18A-E. Time series, satellite smoke image, and modeling results for Oakridge monitor, 9/16/17.

Figure 18A.

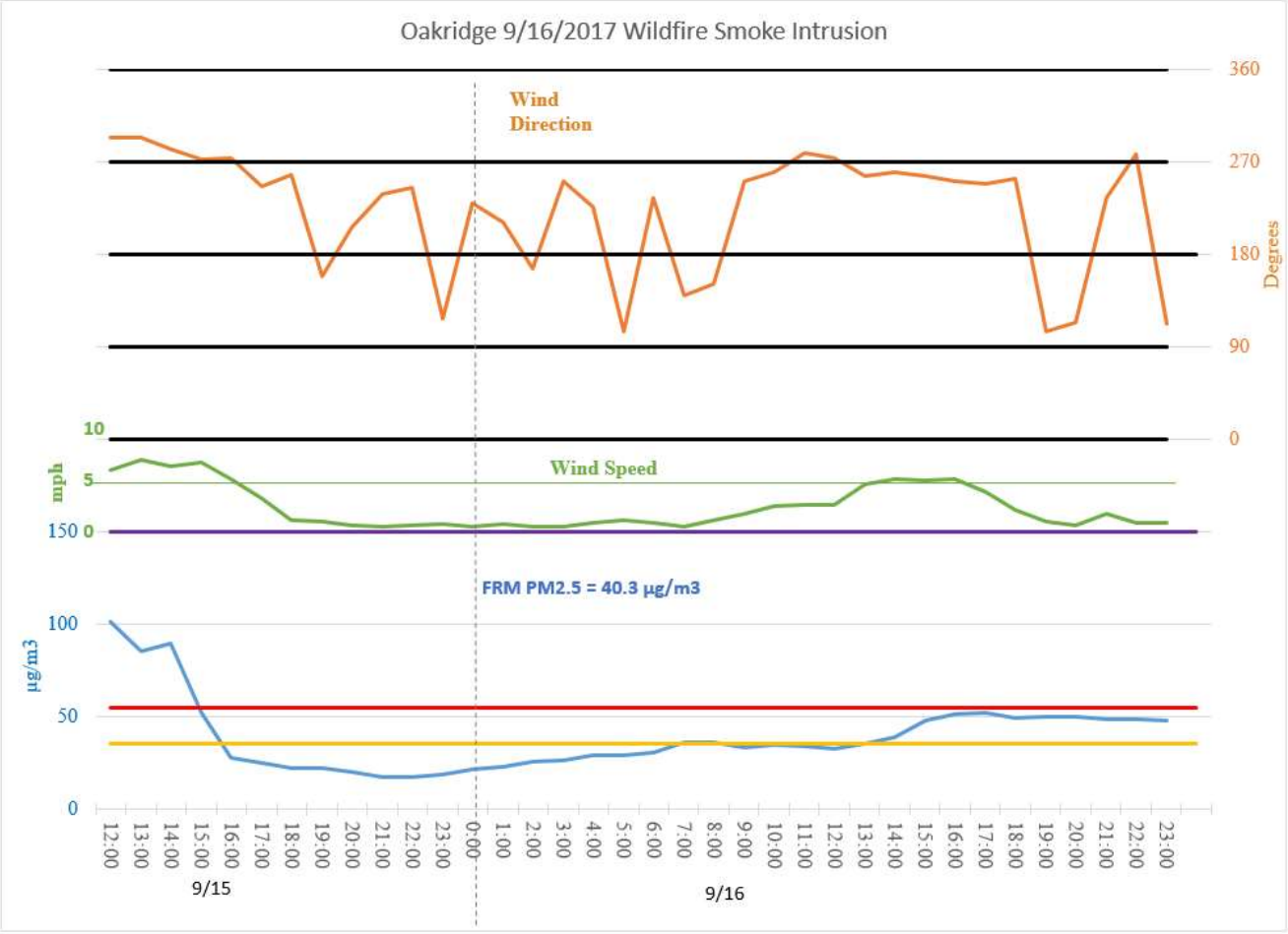


Figure 18B.

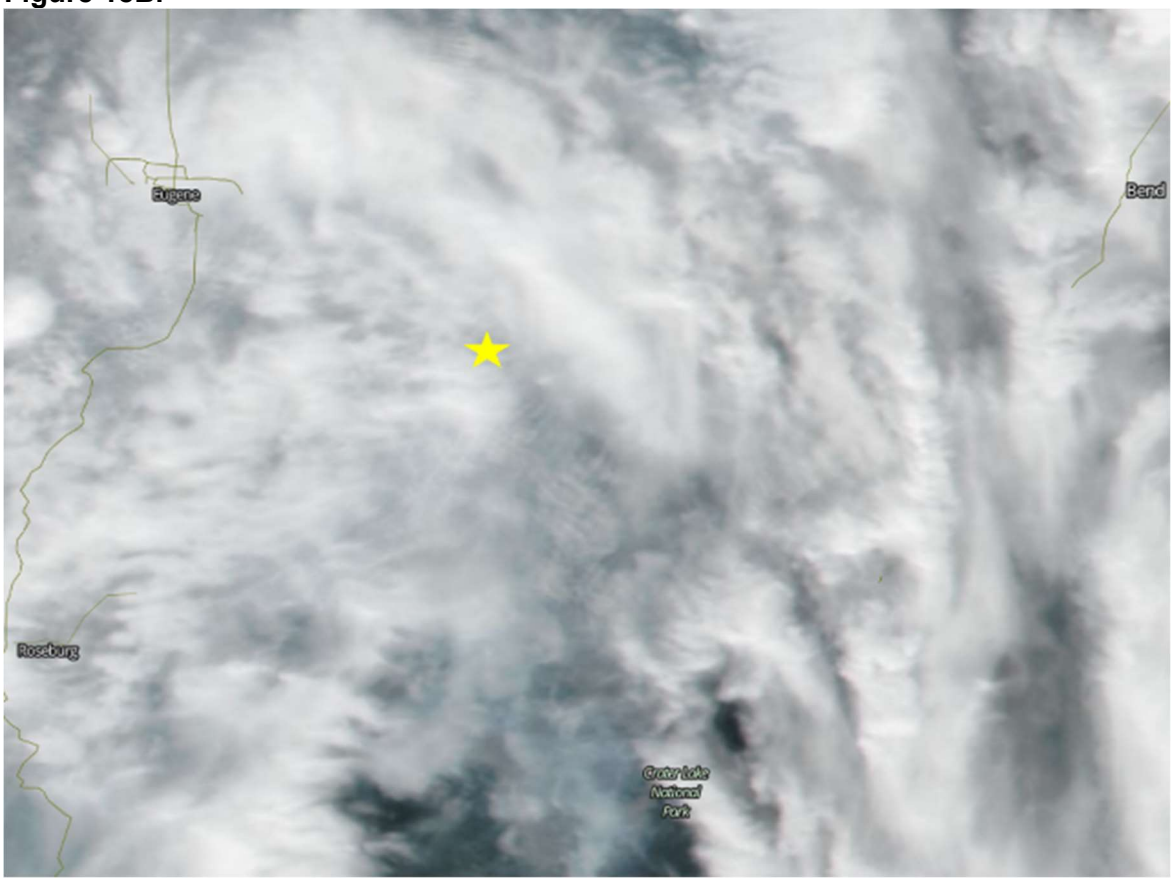


Figure 18C.

Figure 18D.

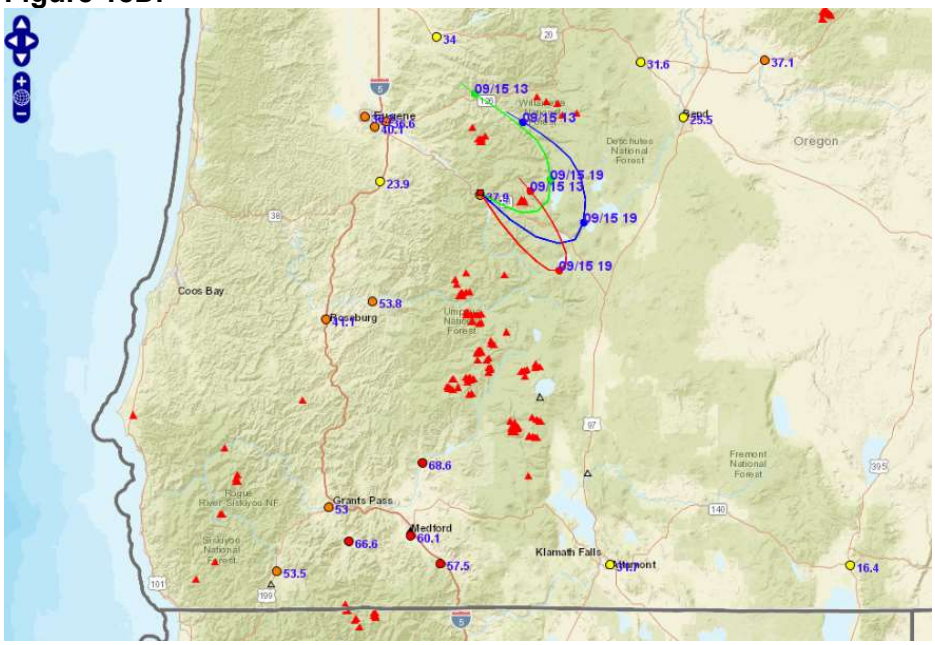
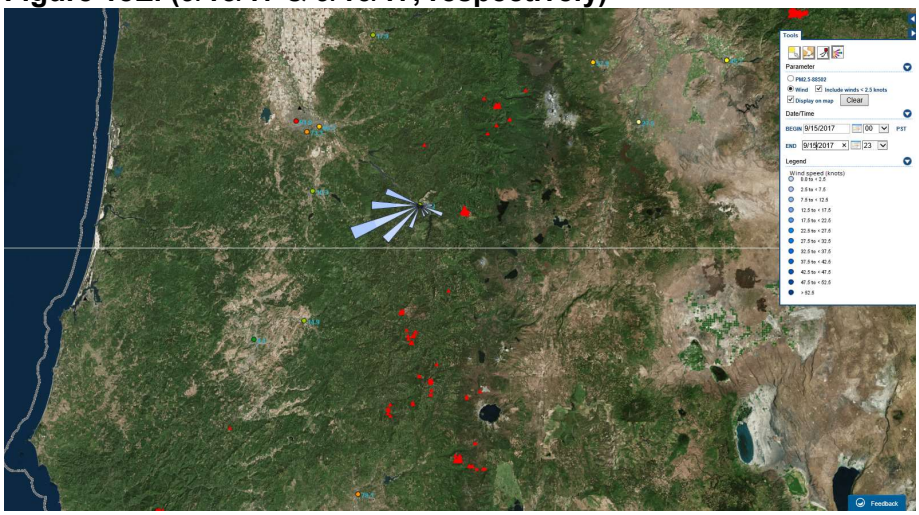
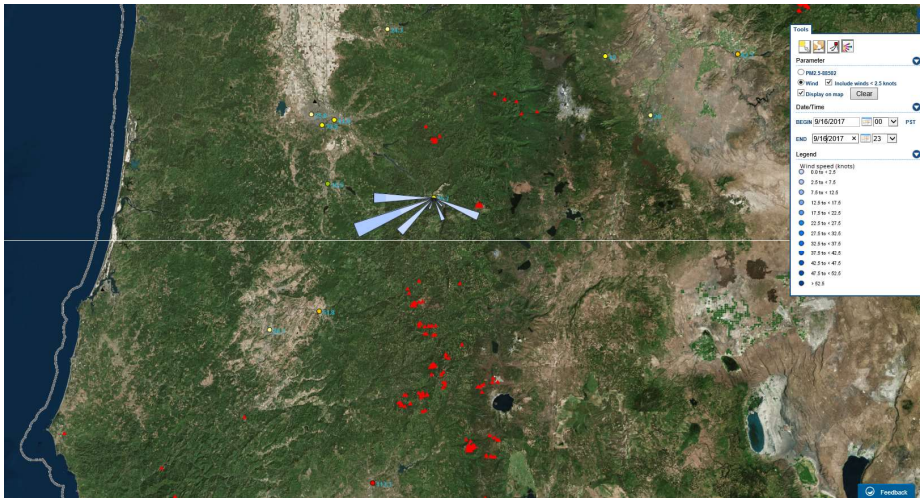


Figure 18E. (9/15/17 & 9/16/17, respectively)





2 Clear causal relationship

A clear causal relationship between a source and monitor is demonstrated with multiple strands of evidence linking the source of the event to the monitored exceedance. DEQ provides a concise description of how the evidence for each day demonstrates the clear causal relationship. In addition, alternative sources of PM2.5 and PM10 are explored.

Specifically,

(1) Meteorological evidence (time series): transport of emissions to monitor
(2) Satellite, back trajectory, and/or wind rose evidence: spatial relationship between source and monitor
(3) Alternative sources

2.1 Meteorological data and time series

Meteorological data was gathered and provided by our technical services and laboratory liaison, Anthony Barnack. He took wind speed and wind direction at the monitor as well as the hourly PM2.5 reading at the monitor to develop a three-tiered time series graph that shows the relationship of PM2.5 reading with wind speed and direction on the days of interest. We used that data to backtrack the wildfires that most likely contributed to the high readings of the days of interest.

2.2 Satellite Data, Back Trajectories and Wind Roses

We examined MODIS Terra and MODIS Aqua satellite photos provided through NASA's EOSDIS WorldView for smoke images related to monitor sites on the flagged wildfire days. MODIS satellite photos give visual evidence of the size and direction of the smoke plume on affected days. For a few days where smoke was not obviously coming from a fire to the monitor in question, we also examined Aerosol Optical Depth to identify the presence of wildfire smoke.

HYSPLIT back trajectory and wind rose modeling were conducted through EPA's AirNowTech website The HYSPLIT model shows the back trajectory from the monitor to show that smoke traveled from the direction of the wildfires in questions to the monitor. The HYSPLIT model also shows the trajectory of smoke at varying heights. The wind speed and direction at the monitor and at the fire show the direction of the smoke when it impacted the monitor. For some days where wind direction and speed carried dramatically, wind roses were useful to show the distribution of wind directions, especially when HYSPLIT, which used an average wind direction for the day, showed us a back trajectory that didn't match with the time series data above.

2.3 Alternative Source Hypotheses

An important element of the clear causal relationship demonstration is to explore alternative hypotheses for sources of PM2.5 and PM10. Anthropogenic sources include prescribed fires, crop residue burning (CRB), residential wood combustion (RWC), open burning, and vehicle

emissions. These anthropogenic sources maintain relatively steady emissions from year to year ad are included in historical monitor values.

2.3.1 Prescribed Burning

Oregon Department of Forestry reported no prescribed burns in Klamath Falls or Oakridge for the impacted monitor days.[7]

2.3.2 Crop Residue & Agricultural Burning

Crop residue burning is regulated in Oregon by the Oregon Department of Agriculture in conjunction with multi-agency smoke management efforts, including the Oregon Department of Forestry, Oregon Department of Environmental Quality, and the Oregon State Fire Marshal. ODA's field burning rules are listed in OAR 603-077, "Field Burning Rules," for the Willamette Valley only.[8] The open burning of all other agricultural waste is governed by OAR 340-264, "Rules for Open Burning."

No open burning is allowed in Klamath Falls during the period in question.

The backyard open burning period in Oakridge is only allowed with a permit during the months of October, March, April, and May (LRAPA Section 47-015(2)(f)). Thus, open burning was prohibited on the impacted monitor days in question.

2.3.3 Residential Wood Combustion

Residential wood combustion can be a significant source of PM2.5 emissions in Oregon communities during the winter months. The temperatures in Klamath Falls and Oakridge on the dates in question were well above the temperatures at which anyone would be burning wood for residential heating purposes. RWC was not a likely source of PM2.5 emissions during this time period.

Table 8. Maximum and minimum daily temperatures at the Klamath Falls and Oakridge monitors on impacted days, 2017

Klamath Falls				Oakridge			
Date	PM2.5	Max Temp (F)	Min Temp (F)	Date	PM2.5	Max Temp (F)	Min Temp (F)
8/17/2017	34.6	86.7	49.5	8/26/2017	42.2	88.3	47.3
8/20/2017	55.1	84.0	50.0	8/29/2017	88.5	87.2	55.2
8/23/2017	32.7	82.6	59.0	9/1/2017	86.2	91.6	53.2
8/26/2017	44.7	87.4	51.1	9/4/2017	200	90.1	53.9
8/29/2017	69.3	91.9	50.9	9/7/2017	66.9	80.1	64.6
9/1/2017	50.6	90.5	51.3	9/16/2017	40.3	73.4	45.2
9/4/2017	102	94.1	57.0				

[7] Direct correspondence with Nick Yonker, Oregon Department of Forestry, 3/5/2019.
[8] The Willamette Valley is extremely distant from the monitors in question, for those not familiar with the geography of Oregon.

2.3.4 Open Burning

Open burning in Oregon is regulated by OAR 340-264.[9] Oregon

> "Classifies all open burning into one of seven classes: Agricultural; Commercial; Construction; Demolition (which includes land clearing); Domestic (which includes burning commonly called "backyard burning" and burning of yard debris); Industrial; or Slash. Except for field burning within the Willamette Valley regulated through OAR 340 division 266 and slash burning administered by the forest practices smoke management plan of the Oregon Department of Forestry, this division prescribes requirements for and prohibitions of open burning for every location in the state. Generally, if a class of open burning is not specifically prohibited in a given location, then it is authorized subject to OAR 340-264-0050 and 340-264-0060 and the requirements and prohibitions of local jurisdictions and the State Fire Marshal."[10]

In addition, according to OAR 340-262-0900, "Materials Prohibited from Burning,"

> No person may cause or allow any of the following materials to be burned in a solid fuel burning device, fireplace, a trash burner or any other device described in ORS 468A.485(4)(b):
>
> (1)(a) Garbage; (b) Treated wood; (c) Plastic or plastic products; (d) Rubber or rubber products; (e) Animal carcasses; (f) Products that contain asphalt; (g) Waste petroleum products; (h) Paint; (i) Chemicals; (j) Products containing lead, mercury or other heavy or toxic metals; (k) Materials containing asbestos; and (l) Particleboard.
>
> (2) Paper or paper products, except for paper used to kindle a fire.

No open burning is allowed in Klamath Falls during the period in question.

The backyard open burning period in Oakridge is only allowed with a permit during the months of October, March, April, and May (LRAPA Section 47-015(2)(f)). Thus, open burning was prohibited on the impacted monitor days in question. Barrel burns are prohibited in Lane County.

According to the Oregon Department of Forestry, no prescribed burns or open burns were registered on any of the impacted days in Klamath Falls or Oakridge.

2.3.5 Vehicle Emissions

Vehicle emissions and road dust produce PM2.5 emissions and are included in the onroad mobile source category in the 2014 NEI. The annual PM2.5 emissions in this category are a small fraction of the emissions produced by wildfires, especially in rural areas like Klamath Falls and Oakridge, with few vehicles.

[9] Oregon Secretary of State website. "Rules for Open Burning." (Accessed 3/5/2019) https://secure.sos.state.or.us/oard/displayDivisionRules.action;JSESSIONID_OARD=cC9P1ta7Uus8P2xtYZlahJLghrbyYGUCt0sDOMyytWOQg9umWVQF!1318524005?selectedDivision=1568

[10] OAR 340-262-0010 (1).

The Updated Oakridge-Westfir PM2.5 Attainment Plan (LRAPA 2016)[11] used the 2008 NEI as the basis for estimating PM2.5 in 2015. Road dust and mobile on road emissions account for up to 10% of PM2.5 on the worst winter days and less than 5% of PM2.5 on average days. Similarly, the Klamath Falls Fine Particulate Matter (PM2.5) Attainment Plan (DEQ 2012)[12] also models onroad emissions contributions to PM2.5 levels as minimal. Onroad mobile emissions did not likely contribute any significant PM2.5 to the elevated concentrations at the monitors in question on the impacted days.

[11] LRAPA 2016. *Updated Oakridge-Westfir PM2.5 Attainment Plan.* Springfield, OR. https://www.oregon.gov/deq/EQCdocs/0117ItemEAttachC.pdf

[12] Oregon Department of Environmental Quality. 2012. *Klamath Falls Fine Particulate Matter (PM2.5) Attainment Plan*. Portland, OR. https://www.oregon.gov/deq/FilterDocs/KFallsAttPlan2012.pdf

3 Comparison to historical fluctuations

To support the clear causal relationship requirement of the EER, analyses are presented here comparing the event-influenced concentrations at Klamath Falls and Oakridge to historical concentrations. Evidence supports the conclusion that PM2.5 concentrations at the two monitors on the flagged days were elevated due to wildfire smoke.

Figures 19 and 20 shows the PM2.5 concentrations measured at Klamath Falls and Oakridge, respectively, for 2008 through 2017. This data shows that during wildfire season (June through September) PM2.5 measurements typically remain below 30 ug/m3 with occasional excursions up to 40 ug/m3 in Klamath Falls and 50 ug/m3 for Oakridge. Higher numbers in the wintertime are attributed to residential wood combustion and wintertime inversions in our mountain valleys. The flagged days for 2017 are shown as orange triangles on the charts, while forest fire days for Klamath Falls in 2014 and 2015 are shown as grey circles.

The exception is when there are wildland fire smoke incursions during the summer months. In this section we show that the summer background PM2.5 levels are below 12ug/m3 on the vast majority of days. June through September data was analyzed for 2008 through 2016 to establish a background level. The FRM data was used when there was a sample day, otherwise PM2.5 estimates from the nephelometer were used. Tables 9 and 10 show that 2017 PM2.5 readings were truly exceptional, even given wildfire years within the 2008-2016 years, at both Klamath and Oakridge monitors.

Table 9. Basic descriptive statistics for 24-hr PM2.5 concentrations recorded at Klamath Falls Peterson School, June 1 – September 30, 2008 - 2017

	2008-2016	2017
Minimum	0.6	1.9
Maximum	84.8	102.0
Median	5.0	6.4
Mean	7.6	16.6
STD	9.8	21.4
N	353	40

Table 10. Basic descriptive statistics for 24-hr PM2.5 concentrations recorded at Oakridge monitor, June 1 – September 30, 2008 – 2017

	2008-2016	2017
Minimum	0.2	1.3
Maximum	36.5	200.0
Median	4.7	5.2
Mean	5.7	18.8
STD	4.4	35.2
N	364	43

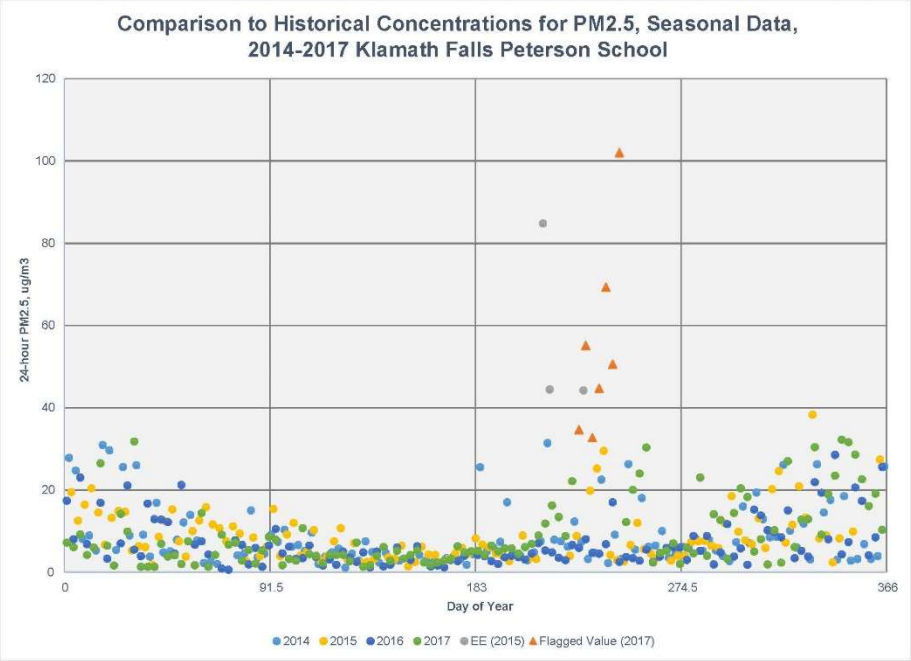
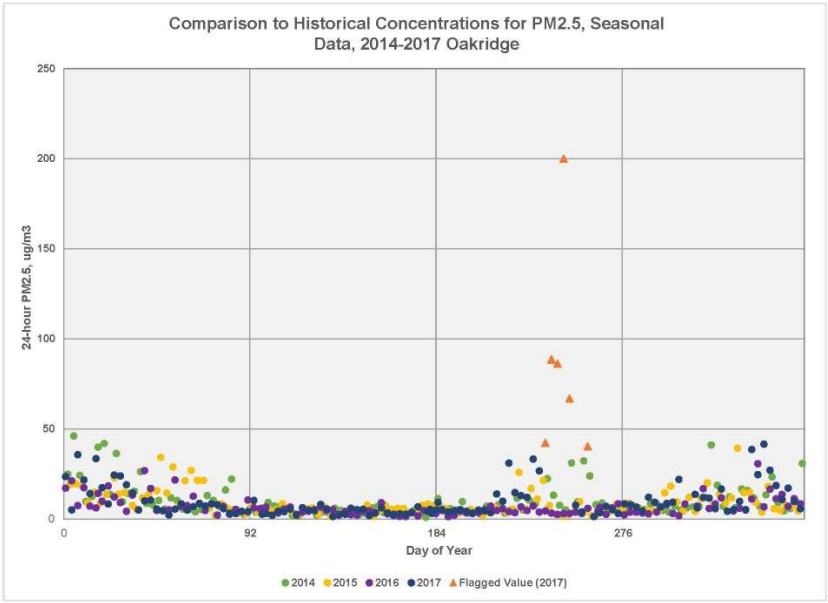


Figure 19. Historical Comparison of PM2.5 Concentrations at Klamath Falls Peterson School Monitor with forest fire days.

Figure 20. Historical Comparison of PM2.5 Concentrations at Oakridge Monitor with forest fire days.



4 Not reasonably controllable or preventable

This EER element requires a demonstration that the event was neither reasonable controllable not preventable, and this requirement has been met for wildfire events (40 CFR 50.14(b)(4)). DEQ presents sufficient evidence in this demonstration showing the source of the event was indeed wildfires (section 1, section 2). DEQ contends that the events of August and September 2017 at Klamath and Oakridge were both not reasonably controllable or preventable.

5 Natural Event or Human Activity unlikely to Recur (NE/HAUR)

The EER requires that agencies must document that the identified source of an exceptional event is either a natural event (NE) or a human activity unlikely to recur at the same location (HAURL) such as to affect the monitors in question again. EPA's 2016 Exceptional Events rule indicates that if an agency has adequately demonstrated that the source is a *natural event* or, if not natural, is a human activity unlikely recur at the same location and that there is a *clear causal relationship* between the identified source (s) and the affected monitor, then the HAURL/Natural Event criterion is also satisfied.

The fires in 2017 were largely due to lightning strikes after a wet spring that saw rapid growth of understory woody and herbal plant material, followed by record-breaking hot and dry summer season that converted this new, thin growth into fuel. These lightning-caused wildfire events are considered natural events. The detailed data included in Chapter 1 and 2 demonstrate a clear causal relationship between source and monitor for each day that ODEQ requests concurrence. Thus, the NE/HAUR criterion is also satisfied.

6 Mitigation

The EER requires states to take appropriate and reasonable actions to protect public health from exceedances or violations of the NAAQS (40CFR 51.930). DEQ presents evidence of prompt public notification of the event, public education so that individuals could make behavioral changes to reduce exposure to unhealthy air, and implementation of appropriate measures to protect public health from the impacts of exceptional events.

Control of wildland fires is coordinated under the National Interagency Fire Center. Their fire control policy states:

> Five federal agencies, including the Depart of the Interior's Bureau of Land Management, Bureau of Indian Affairs, National Park Service, and U.S. Fish and Wildlife Service, along with the Department of Agriculture's Forest Service, manage and have primary fire program responsibilities on more than 676 million acres. The U.S. Fire Administration works with county and local fire departments; while the states are represented by the National Association of State Foresters. The state, county, and local jurisdictions provide primary fire protection on public and private lands covering additional hundreds of millions of acres across all 50 states.
>
> As partners, they work together on fire management issues covering the spectrum from safety and planning, to science, preparedness, operations, strategy development, logistics, intelligence, emergency response, and more. They also collaborate on interagency strategies to manage wildfires, not only for single incidents but as a matter of policy.

In addition to the total effort of the various natural resource agencies, the specific USFS districts prepare fire management plans.[13]

Oregon DEQ, Lane Regional Air Pollution Authority, Oregon Health Authority, Oregon OSHA, Oregon Emergency Management, Oregon Department of Forestry, and the US Forest Service developed a wildfire response protocol which outlines the state, federal, and local response to dangerous smoke levels impacting Oregon communities.[14] The protocol defines which agency is responsible for which activity and provides a guide for the coordination of emergency communication during extreme smoke events.

The major areas of agency actions and the lead agencies responsible the event of a severe smoke episode related to wildfire are presented in detail in Table 10.

[13] For more details for fire management and community outreach practices during the 2017 fire season, see: USDA Forest Service and DOI Bureau of Land Management. *2017 Pacific Northwest Fire Narrative.* https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd572804.pdf (Accessed March 4, 2019)

[14] Oregon DEQ et al. 2018. *Oregon Wildfire Response Protocol for Severe Smoke Episodes.* V5.3. June 28, 2018. https://www.oregon.gov/deq/FilterDocs/WFresponse.pdf (Accessed March 4, 2019).

Table 11. Wildfire response protocol: actions and agencies responsible.[15]		
Action Needed	**Lead Agency and Action Taken**	**Desired Outcome**
1. Air Monitoring		
Measuring ambient air quality	**Mostly DEQ as lead agency. Air Resource Advisors (ARA) may provide additional monitoring equipment via national cache resources and assist in deployment and data collection.**	**Ability to track ambient air quality levels in communities receiving the heaviest impact, and identify smoke-free areas where air quality is good.**
Indoor air quality exposure	**Oregon OSHA is lead agency to evaluate air quality concerns for workers. DEQ and OHA can provide advice to schools.**	**Ability to monitor indoor smoke levels in work environments and schools.**
2. Smoke Forecasting and Modeling		
Smoke weather forecast	**ODF is the lead agency, with back-up and assistance from NWS Meteorologists as requested. DEQ assists in coordination. National Weather Service can be contacted to provide "spot weather forecasts" for wildfire.**	**Provide advance notice of possible smoke movement and impacts, improve public notification, lower risk of public exposure to high smoke levels**
Smoke modeling	**ARAs can provide smoke modeling forecasts if requested.**	**Complementary to above**
3. Issuing Health Warnings		
Provide public with frequent smoke updates on potential health risk and recommended public health actions via the web and media	**Coordination between the Incident Management Team, DEQ, ARA, OHA, county health departments, local government, tribes and 211 info. Assistance from federal land managers on fire status, and from ODF wildfire forecasting.**	**Frequent coofdinated updates provided to the public via Oregon Smoke Blog, DEQ, OHA, local govermnet websites, press releases and media outreach. 211 info is provided with up-to-date health-related information.**
4. Website management		

[15] Oregon DEQ et al. 2018. *Oregon Wildfire Response Protocol for Severe Smoke Episodes.* V5.3. (June 28, 2018) pages 5-6. https://www.oregon.gov/deq/FilterDocs/WFresponse.pdf (Accessed March 4, 2019).

Updating the Oregon Smoke Blog and social media (see description under section 6)	**Blog initiated by federal land managers or DEQ, and updated by DEQ Public Affairs who will act as a "gate keeper" to avoid duplicative messaging and crowding of the smoke blog.**	**Provide the public with comprehensive "one-stop" website/social media on wildfire status, air quality levels, leath risk, cleaner air spaces, press releases and other critical info.**
Updating DEQ, OHA, ODF and local websites	**Managed by respective agency. Supplements the Oregon Smoke Blog website.**	**Complements the above website.**
5. Public Actions		
Cancel or modify public events, outdoor and business activities	**Decision made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, ARA, local public health, OHA, federal land managers, and possibly or OR-OSHA as needed.**	**Prompt action taken, via notification of media, 211 info, and posting info on Oregon Smoke Blog and other websites**
Consult with schools on limited hours or closure. Decisions about protecting schools or other public buildings from smoke intrusion	**Decision made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, ARA, local public health, OHA, or OR-OSHA as needed.**	**Identification of measures to protect schools and users of public buildings from smoke**
Set up general population shelters	**Red Cross may support the setup and management of general population shelters based on decisions by local health officials.**	**When determined necessary, general population shelters will be established and opened in coordination with local public health and emergency management.**
Establish or identify public cleaner air spaces	**Decisions made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, ARA, OHA, or OR-OSHA as needed.**	**When determined necessary, prompt action taken to set up or identify cleaner air spaces, using guidance for "Identifcation of Cleaner Air Spaces for Protection from Wildfire Smoke"[1]**
Recommended evacuation/relocation of sensitive populations	**Decision made at local level, by health officials and tribal/local government (Sheriff or local emergency**	**Prompt action taken if dangerous smoke levels are expected to persis for a prolonged period. Requires**

	management), OEM, in consultation with DEQ, ARA, OHA, federal land managers and possibly OR-OSHA	**close communication with DEQ, OHA, federal land managers, OEM, OR-OSHA, 211 info, and possibly Red Cross, State Fire Marshal and State Police.**

7 Initial Notification

The EER establishes specific procedural requirements that an air agency must follow to request data exclusion. Those requirements and ODEQ's actions to meet them are summarized in the table below.

Table 12. Exceptional Event Rule Procedure Requirements

Exceptional Event Rule Procedural Requirement	ODEQ Action/Intended Action
A State shall notify EPA of its intent to exclude one or more measured exceedances of an applicable ambient air quality standard as being due to an exceptional event by placing a flag in the appropriate field for the data record of concern which has been submitted to the AQS database... 40 CFR § 50.14(c)(2)(i).	ODEQ notified EPA that it placed flags on numerous the monitor values originally thought to be affected by wildfires above the level of concern in Oregon for PM2.5 of 25µg/m3 and that we intended to request EPA concurrence to exclude some or all of them from the AQS database.
A State that has flagged data as being due to an exceptional event and is requesting exclusion of the affected measurement data shall, after notice and opportunity for public comment, submit a demonstration to justify data exclusion to EPA. EPA shall respond with a due date for demonstration submittal that considers the nature of the event and the anticipated timing of the associated regulatory decision. 40 CFR § (50.14(c)(3)(i)).	DEQ made this package available for public comment and subsequently submitted it to EPA by June 1, 2017 so that it continues to demonstrate Klamath Falls is meeting the 24-hour PM2.5 standard.
With the submission of the demonstration, the air agency must document that the public comment process was followed. 40 CFR § (50.14(c)(3)(iv) and (v).	This document was available for a 30-day public comment from April 12 through May 15, 2017. See Appendix A for notifications of public comment. One public comment was received.

DEQ posted notice of this exceptional events demonstration on April 19, 2019 on the DEQ website. No comments were received.

From:	DEQ Online Subscriptions
To:	STOUT Holly; SAKATA Rachel; GAMOLO Gerald; SEVEN Jenni; KENNY Jennifer; MCMORRINE Edith; FLYNT Jennifer; MILLER Denise; SVELUND Greg; SAWKA Nancy; HNIDEY Emil
Subject:	Courtesy Copy: DEQ invites the public to comment on the 2017 Klamath Falls and Oakridge Exceptional Event EPA Concurrence Request document
Date:	Friday, April 19, 2019 5:05:59 PM

This is a courtesy copy of an email bulletin sent by Emil Hnidey.

This bulletin was sent to the following groups of people:

Subscribers of Air Quality Maintenance Plans, DEQ Public Notices, or Klamath Falls Air Pollution, (6609 recipients)

Summary

DEQ invites the public to submit written comments on the 2017 Klamath Falls and Oakridge Exceptional Event EPA Concurrence Request document.

Klamath Falls and Oakridge air monitors experienced smoke from wildfire events in 2017 that caused, in part, higher levels of PM2.5 (fine particle pollution) that violated the National Ambient Air Quality Standards. DEQ developed an Exceptional Event Request document requesting that EPA exclude data that are directly related to the wildfire from use in the 2017 regulatory determinations.

The public notice and Exceptional Event Request document can be viewed here:
https://www.oregon.gov/deq/get-involved/documents/052019kfallsoakridge.pdf

How do I participate?

To submit your comments for the public record, send them by mail, fax or email:

D Pei Wu, PhD
Air Quality Planner
700 NE Multnomah St, Suite 600
Portland, OR 97232
Fax: 503-229-6124
Email: wu.d@deq.state.or.us

Written comments are due by 5 p.m. May 20, 2019.

What is an exceptional event?

Exceptional events are unusual or naturally occurring events that can affect air quality but are not reasonably controllable. Exceptional events include wildfires, high wind dust events, and other activities not caused by people.

Why is the request needed?

Data that is over the standard and has regulatory implications can be removed by request, if it has been influenced by exceptional events. In order for Klamath Falls and Oakridge to show they have attained the standard under their respective federally approved attainment plans, this data needs to be excluded.

NEWS AND ANNOUNCEMENTS:

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8 Public Comment

From: DEQ Online Subscriptions
To: HNIDEY Emil
Subject: Bulletin Detail Report: DEQ invites the public to comment on the 2017 Klamath Falls and Oakridge Exceptional Event EPA Concurrence Request document
Date: Friday, April 19, 2019 9:06:05 PM

Having trouble viewing this email? View this report in your account.

GovDelivery

Report Generated: 04/19/2019 09:06 PM PDT

This report automatically generates after a bulletin is sent. View the Bulletin Detail Report online to see the most recent performance metrics for this bulletin.

Subject: DEQ invites the public to comment on the 2017 Klamath Falls and Oakridge Exceptional Event EPA Concurrence Request document

Sent: 04/19/2019 07:05 PM CDT

Sent By: hnidey.emil@deq.state.or.us

Sent To: Subscribers of Air Quality Maintenance Plans, DEQ Public Notices, or Klamath Falls Air Pollution,

6,609 Recipients

Email
SMS
Facebook
Twitter
RSS

96.3% Delivered

1% Pending
3% Bounced
7% Open Rate
0% Click Rate

Email Delivery Stats

Minutes	Cumulative Attempted
3	99%
5	99%
10	99%
30	99%
60	99%

Email delivery statistics line / bar chart

120 99%

Delivery Metrics - Details

6,609 Total Sent

6,363 (96%) Delivered

42 (1%) Pending

204 (3%) Bounced

1 (0%) Unsubscribed

Bulletin Analytics

495 Total Opens

406 (7%) Unique Opens

8 Total Clicks

8 (0%) Unique Clicks

7 # of Links

Delivery and Performance

Channel	Progress	Percent Delivered	Number of Recipients	Number Delivered	Opened / Unique	Bounced / Failed	Unsubscribed
Email Bulletin	Sending...	95.9%	5,933	5,687	406 / 7.1%	204	1
SMS Message	Delivered	100.0%	256	256	n/a	0	n/a

Bulletin Link Overview

Link URL	Unique Clicks	Total Clicks
https://www.oregon.gov/deq/get-involved/documents/052019kfallsoakridge.pdf	6	6
https://public.govdelivery.com/accounts/ORDEQ/subscriber/one_click_unsub...	1	1
https://public.govdelivery.com/accounts/ORDEQ/subscriber/edit?preference...	1	1
https://twitter.com/OregonDEQ	0	0
https://subscriberhelp.govdelivery.com/	0	0
https://www.facebook.com/oregondeq	0	0
http://www.oregon.gov/deq/	0	0

Need more reports? Additional reporting is available in your account. If you want additional information on reporting, please visit the reporting help menu.

Want to learn more about these metrics and the best practices for improving results? Contact your dedicated Client Success Consultant! Not sure who that is? Send us an email at help@govdelivery.com and we'll help you find out.

9 Summary

With the weight of evidence discussed throughout this report, Oregon DEQ has shown that the smoke from the Crater Lake and Umpqua North forest fires caused the PM2.5 concentration collected on the ODEQ Federal Reference Method Klamath Falls samplers in August and September 2017, and that fires from the Willamette Forest Fires similarly impacted the monitors at Oakridge. ODEQ requests EPA's concurrence and that these values not be used to calculate the relevant design values for the Klamath Falls State Implementation Plan and for the Oakridge State Implementation Plan.

ODEQ is also submitting some dates for which EPA will not concur at the moment, but for which the information may become of regulatory significance in the future.

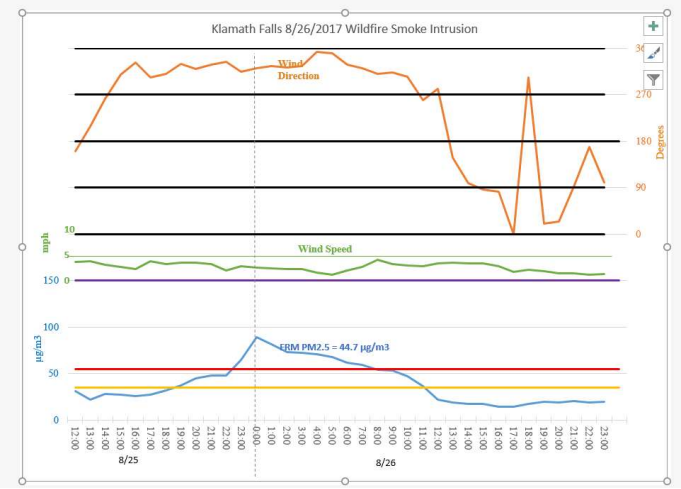
Appendix A

HYSPLIT back trajectory protocol for exceptional events in AirNow-Tech
By Anthony Barnack

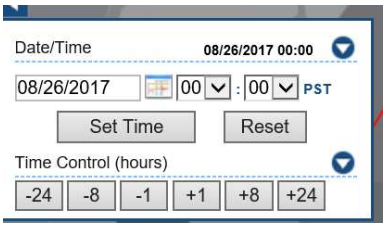
Instructions:
Log onto Airnow Tech and go to the Navigator tab. You will need an account to log on.

1. Under the Parameter Tab Select:
   PM2.5-88502
   Duration 1 hr
   Display – parameter, HMS fire, and HMS smoke if you want
2. Under the Site Tab Select:
   By Parameter - PM2.5-88502
   By Duration – 1 HR
3. Under the Layers Tab Select:
   I usually add the states border. You can also add the MODIS satellite images if it helps.
4. My maps – Leave as Standard

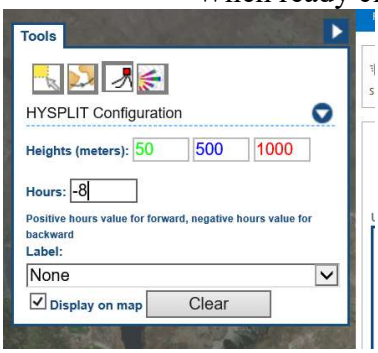
5. Setting the time and date on the map.
   I usually look at the time series to see what time of day the biggest impact was and the WD and WS at the time.
   For KFalls, 8/26/17, the impact was at 0:00 PST with winds from the NNW. This tells you when to set your map time and what fires you will be looking at.



6. Set the map time



7. Under the lower arrow at the upper right is the tool box.
   Select the red box for Hysplit. I use 50, 500, and 1000 meters.
   You can do a back trajectory by putting negative hours in and clicking on the site.
   Forward trajectory is from the forest fire and positive hours.
   When ready click on the site or fire you want a trajectory for.



Notes:
I use the HMS smoke discussed in step 1 to see where the old smoke is and get an idea of where the smoke is heading. I turn it off to see the map. It usually takes many iterations of changing the trajectory hours to see where the impact came from. Here is the Hysplit for 8/26/17. The fires are 8 hour forward trajectory from 8/25/17 16:00 (8 hrs before the high impact). The site is an 8 hr back trajectory. The KFalls back trajectory shows that the fire to the northwest of KFalls was likely most responsible but there is also latent smoke from the other fires that remains aloft and slides down the east slopes of the Cascades at night when the air cools. This is pretty common in KFalls, so any smoke over the Cascades slides down when the air cools into the valleys.